## SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY ORGANIZATION AND MANAGEMENT SERIES NO. 219

## INNOVATIONS IN DISTRIBUTION LOGISTICS SUPPORTING THE ADAPTATION OF LOGISTICS OPERATORS TO CHANGING MARKET CHALLENGES

# Anita FAJCZAK-KOWALSKA<sup>1\*</sup>, Grzegorz MAZURKIEWICZ<sup>2</sup>

<sup>1</sup> Lodz University of Technology, Wydział Fizyki Technicznej, Informatyki i Matematyki Stosowanej, Instytut Informatyki; anita.fajczak-kowalska@p.lodz.pl, ORCID: 0000-0002-5347-9735

<sup>2</sup>Lodz University of Technology, Faculty of Organization and Management, Institute of Management, Supply Chain Management Department; grzegorz.mazurkiewicz@p.lodz.pl, ORCID: 0000-0002-3494-825X \* Correspondence author

**Purpose:** The purpose of this article is to present innovations in distribution logistics as a key factor supporting the adaptation of logistics operators to dynamically changing market conditions.

**Methodology:** The article uses an analytical approach, based on a literature review and empirical research. The study was based on an electronic CAWI survey conducted among respondents representing various segments of the logistics industry.

**Findings:** The analysis of the results allowed for the identification of trends and barriers in the implementation of innovations in logistics.

**Research limitations and implications:** The study was cross-sectional and covered a selected group of respondents, which may influence the generalization of the results. In the future, it would be beneficial to expand the analysis to include data from different markets and to study the long-term effects of implementing innovations in distribution logistics.

**Practical implications:** The research results indicate the need for investment in digital technologies, automation, and employee skills development in the logistics sector. Companies should also consider collaboration with technology entities and suppliers of innovative solutions, which could allow for faster implementation of modern distribution models.

**Social implications:** The use of modern technologies in distribution logistics could contribute to reducing  $CO_2$  emissions, improving working conditions in the sector, and increasing the accessibility of logistics services. The impact of innovations on the labor market, however, requires further analysis, especially in the context of replacing traditional positions with automated systems.

**Originality/Value:** The article contributes to the literature on distribution logistics by presenting current trends and challenges associated with the implementation of innovations in this sector.

**Keywords:** Logistics innovations, distribution logistics, process automation, supply chain optimization, technologies.

Category of the paper: Research paper.

## 1. Introduction

Innovations in distribution logistics are a key element supporting the development of logistics operators in the face of continuously changing market conditions. Globalization, the development of new technologies, changing consumer needs, and the increasing pressure for sustainable development require logistics companies to adapt their strategies, processes, and tools to meet new challenges. In light of these dynamic changes, innovations not only respond to market expectations but also serve as the foundation for maintaining competitiveness and operational efficiency.

Contemporary challenges in distribution logistics include, among others, the increased complexity of supply chains, the need for faster and more flexible customer service, and minimizing costs while maintaining high service quality. Innovations in logistics processes, such as route optimization, the introduction of new transportation methods, warehouse automation, and the development of parcel tracking technologies, are becoming essential. Logistics operators must not only invest in new technologies but also adapt them in a way that allows for effective integration with existing processes.

It is also important to note that innovations in distribution logistics extend beyond technology to include organizational and process changes. An example of this is the development of last-mile logistics, which is becoming increasingly critical in response to growing consumer expectations for fast and convenient delivery. Logistics operators are changing their approach to managing distribution networks, focusing on greater flexibility, proximity to customers, and cost reduction. Innovative approaches to organizing distribution processes allow for better alignment of services with the evolving needs of the market and customer expectations.

The aim of this article is to present innovations in distribution logistics as a key factor supporting the adaptation of logistics operators to dynamically changing market conditions.

## 2. Specifics of Service Provision in Logistics Companies

Recent practice has solidified the assumption that a company's success and prosperity require focusing on areas where it has an advantage over competitors and those that are crucial for its operations. Therefore, as much as possible, it is necessary to refrain from performing tasks in-house that can be outsourced to other entities that can perform them more cheaply, including logistics processes. According to Rydzkowski, tasks that external companies can handle according to our needs and quality requirements, and generally at a lower cost, should be outsourced to them (Rydzkowski, 2007).

Christopher M. defines a logistics service as the process of managing the flow of goods and information (Christopher, 1998). Ciesielski M. emphasizes the importance of the function and quality of logistics services (Ciesielski, 2005). Harrison A. and van Hoek R. focus on the complexity of logistics services (Harrison, Van Hoek, 2011), while Mentzer J.T., Flint D.J., Hult G.T.M. highlight customer perception and service quality (Mentzer 2001). On the other hand, Krawczyk S. defines a logistics service in the context of outsourcing and logistics operators (Krawczyk, 2012). Rydzkowski W., Wojewódzka-Król K. emphasize the integrative elements of logistics services (Rydzkowski, 2007).

Knowledge of the life cycle of a logistics service provides the basis for making decisions regarding the supply strategy of this service on the market and allows a company to guide its behavior depending on changes in demand or the actions of competing enterprises (Archutowska, 2009). Regarding the life cycle and the time required for each phase of the cycle (seen as stages of service sales), factors such as service price, demand for the service, and the level of its complementarity determine it. The main goals of providing logistics services are:

- Constantly balancing the effects of seasonality in demand for logistics products by entering into contracts with manufacturers regarding the collection and handling of stocks in regional warehouses with unused storage capacity.
- Improving the distribution of logistics infrastructure by diversifying warehouse base locations.
- Reducing transport costs through the use of multimodal, intermodal, or bimodal transport.
- Introducing new products to the market through demand testing by quickly delivering small batches of products simultaneously to multiple sales points in a short time. This form of logistics services is an alternative to large, capital-intensive advertising campaigns organized by producers (Gołębska, 2009).

Logistics services have wide application in the distribution process. Christopher M. (2011) defines distribution as a key element of logistics: "Distribution is the management of goods flow from the producer to the final customer, including transport, warehousing, order fulfillment, and customer service" (Christopher, 2011). Skowronek C., Sarjusz-Wolski Z. (2012) describe distribution in the context of the logistics system (Skowronek 2012), while Gudehus T., Kotzab H. (2012) place distribution in the broader context of supply chain management (Gudehus 2012). Ciesielski M., Długosz J. (2010) emphasize its integrative nature (Ciesielski 2010).

The increasing complexity of logistics systems encourages or sometimes forces companies to outsource logistics services to specialized logistics companies in the TSL (transport, forwarding, logistics) sector. A logistics service provider (operator) can be defined as an external supplier that performs all or part of the logistics functions for the contracting company. This broad definition includes entities providing transport, warehousing, distribution, customs services, etc. Companies are inclined to outsource these processes due to the desire to

reduce costs, focus on their core business activities, and also because of the burdens associated with maintaining their own transport fleet, which involves investment in vehicles, technical facilities, qualified staff, and ensuring constant transport volume, among other things.

Depending on the logistics service provider and its position in the industry, the term "thirdparty logistics" (3PL) is sometimes replaced by terms like "contract logistics" and "outsourcing". There are attempts to distinguish between these terms, but all refer to the use of external logistics service providers. In the case of contract logistics, such cooperation is typically long-term and involves a formal agreement defining the scope of services, the duration of cooperation, responsibility for performed tasks, and any penalties for non-compliance. The term "logistics outsourcing" is also used, meaning outsourcing logistics services to external parties. Skjoett-Larsen T. emphasizes the role of long-term cooperation in contract logistics (Skjoett-Larsen, 2000). Bolumole Y.A. points out the difference between contract logistics and traditional transport services, highlighting the comprehensive management of logistics processes and the integration of the operator's activities with the client's supply chain management system (Bolumole, 2001). Kisperska-Moroń D., Krzyżaniak S. define contract logistics as an advanced form of outsourcing (Kisperska, 2009), while Bowersox D.J., Closs D.J., Cooper M.B. emphasize the strategic importance of contract logistics (Bowersox, 1996), and Lieb R.C., Randall H.L. focus on the value-added elements (Lieb, 1996). Ciesielski M. points out the impact of contract logistics on supply chain efficiency (Ciesielski, 2011), while Langley C.J. Jr., Allen G.R. define contract logistics as a long-term partnership (Langley, 2005).

The concept of contract logistics defines a business model based on cooperation between a company (manufacturer, importer) and a logistics service provider, which involves dividing functions between the two parties. The manufacturing company focuses on its core activities (production, trade, services) and passes on most functions to the logistics company, which are not crucial for its operations but unnecessarily engage its resources. Contract logistics leads to significant cost reduction, for example, by limiting the need to maintain warehouses that are used only part of the year. The entrepreneur does not need to maintain an expensive transport fleet, while the logistics service provider can optimize its processes and efficiently use its fleet through agreements with multiple companies. Many logistics operators collaborate with companies that provide only transport services, ensuring them regular orders, while focusing on the overall organization of goods and services flow for their client.

Logistics service providers vary, from simple freight carriers and operators offering service packages based on customer needs, to those who act as coordinators of supply chains, performing planning, coordinating, and controlling tasks through the use of information systems and their experience based on highly specialized logistics knowledge.

The decision to use logistics operators for distribution can be motivated by strategic reasons, in the sense that the organization acknowledges the need for one or more aspects of the chain to be changed. This decision may also be made for more tactical reasons; for instance, the organization may have an inefficient distribution network or insufficient warehousing capacity. Regardless of whether the decision is strategic or tactical, using logistics service providers (3PL) is fundamentally due to the organization's awareness of its insufficient potential in the aforementioned areas (Brooks Bentz, 2006).

Outsourcing logistics services can improve both the efficiency and effectiveness of the distribution process; however, it is important to note that cooperation with an operator may easily end in failure (i.e., the inability to meet one party's requirements by the other). One of the most common causes of failure lies in unreasonable or unrealistic expectations, often from the party using the operator's services. For example, if an operator is required to reduce transport costs by half, this should be considered an unrealistic demand. Another cause of failure could be a lack of flexibility in the actions of both parties involved. Regardless of the diligence in cooperation, one always has to anticipate unexpected problems and challenges (Tompkins, 2006).

## 3. Innovative Solutions in Distribution Logistics Management

In the field of logistics services, the area of distribution and so-called "last mile logistics" (Last Mile for e-commerce) has gained significant importance. In these areas, innovation is primarily understood as the reduction of costs and delivery time. Both of these factors impact the level of customer service. The growing importance of environmental aspects and sustainable development is also crucial. Logistics operators must meet these expectations, constantly searching for new solutions, often ahead of current needs. Another reason for introducing changes and an innovative approach are the circumstances that force them (staffing issues, the desire to obtain external financial support). One of the first definitions of innovation was formulated by Joseph Schumpeter, who defined innovation as the introduction of a new solution into practice (Schumpeter, 1934). Peter F. Drucker defines innovation as the practical implementation of new ideas in an organization (Drucker, 1985). Everett Rogers focuses on the diffusion of innovation in society (Rogers, 1962). Philip Kotler defines innovation in the context of marketing and management: Innovation is any successful implementation of a creative idea that generates value for the customer (Kotler, 2009). The Oslo Manual 2018, which is of great importance for logistics and transport, contains definitions of innovation because innovations in these sectors (e.g., new parcel tracking technologies, route optimization, warehouse automation) are key to increasing efficiency and sustainable development. According to the definition in the Oslo Manual (OECD), innovation is a new or improved product or process (or a combination of both) that differs significantly from previous products or processes of the entity and that has been made available to potential users (product) or put into use by the entity (process). The term "innovation" can therefore refer both to the action and the result of the action. Innovative activity includes all developmental, financial, and commercial actions undertaken by the company aimed at the creation of innovations for the company. Business innovation is a new or improved product or business process (or a combination of both) that differs significantly from previous products or business processes of the company and has been introduced to the market or put into use by the company.

Compared to the previous edition of the manual, the main change in the definition of business innovation is the reduction of the previous definition to four types of innovation (product, process, organizational, and marketing innovations) and narrowing it to two main types: product innovation and business process innovation. In the revised definition, the ambiguity of the requirement for a "significant" change has also been reduced by comparing both new and improved innovations with the previous products or business processes of the company. The basic definitions of product innovation and business process innovation are as follows: Product innovation is a new or improved product or service that differs significantly from the company's previous products or services and has been introduced to the market. Business process innovation is a new or improved business process for one or more business functions that differs significantly from the company's previous products or business processes and has been put into use by the company.

The updated classification of innovation according to the OECD can also be applied to innovations introduced by logistics operators in the field of distribution (both those already in use and those still in the testing phase).

#### Table 1.

Category of	Examples in distribution logistics		
innovation			
Product	Autonomous delivery systems – the use of autonomous vehicles, drones, and robots in the		
Innovations	distribution process (e.g., Amazon Prime Air, Starship Technologies).		
	Advanced packaging technologies – the use of intelligent RFID labels and IoT sensors that		
allow for monitoring transport conditions (e.g., temperature, humidity).			
<b>New delivery models</b> – the implementation of innovative logistics concepts, such to the customer's vehicle trunk (e.g., Amazon Key, Amazon Key in Car) or dyna points (smart lockers).			
			Ultra-fast distribution technologies – the development of systems like Hyperport Cargo,
			which can significantly reduce delivery times in global supply chains.
Business	The use of advanced data analytics and artificial intelligence (AI) - route optimization,		
Process	demand forecasting, and predictive inventory management using machine learning algorithms		
Innovations	tions (e.g., DHL and Resilience360, UPS ORION, Emapa).		
	Warehouse process automation – the implementation of robotics in distribution centers,		
	such as the use of goods-to-person systems (Amazon Robotics, Ocado Smart Platform).		

*Types of Innovations in Distribution Logistics (Own Study)* 

From the perspective of businesses, however, the effectiveness of implementing an innovation is more important than its proper classification. When companies entrust the distribution of their products to logistics service providers, they expect it to be carried out better (in a shorter time, at a lower cost) than if they were to manage these processes themselves. The introduction of innovation in distribution logistics results from the synergy between external factors, such as market, regulatory, and technological changes, and internal factors, such as organizational culture, resources, and competencies. Logistics operators who effectively identify these factors and respond appropriately can gain a competitive advantage in a dynamically changing environment.

## Table 2.

External and Internal Factors Influencing Innovation in Distribution Logistics (Own Study)

<b>External Factors Affecting Distribution Innovation</b>	Internal Factors Affecting Distribution Innovation
1. Intensification of Market Competition	1. Organizational Culture Supporting Innovation
Increased competition in the logistics market creates	An organizational culture that promotes openness to
pressure on operators, forcing them to implement new	change supports innovation, thus enabling the
technologies and processes to maintain	implementation of modern logistics solutions.
competitiveness and operational efficiency.	
2. Legal Regulations and Changes in Government Policies	2. Technological Potential of the Organization
Changes in legal regulations, such as environmental	The technological capabilities of the enterprise,
protection laws, transport safety standards, or quality	including access to modern 11 systems and
standards, may force the implementation of	infrastructure, are crucial for the effective introduction
distribution	of innovations in distribution.
Changing Consumer Needs and Expectations	2 Allocation of Financial and Investment Pasauroes
Increased consumer expectations such as shorter	Allocating appropriate financial resources for
delivery times flexibility in product access and	technological innovations and the development of
transparency of processes pose a challenge for	logistics infrastructure allows for the effective
logistics operators to implement innovative solutions	implementation of new solutions in distribution
in distribution.	processes.
4. Technological Advancements and Digitization	4. Change Management and Adaptation Capabilities
The development of digital technologies (IoT, Big	The organization's ability to effectively manage the
Data, artificial intelligence) promotes the introduction	change process and adapt to new technologies and
of innovative solutions in distribution processes,	market needs is decisive for the success of innovation
enabling route optimization, warehouse automation,	implementation.
and real-time shipment tracking.	
5. Globalization of Markets and Increasing	5. Organizational Strategy and Innovation Focus
Complexity of Supply Chains	
Globalization and the increasing complexity of supply	Organizations that include innovation as a key element
solutions that enable effective management of	of their strategy are more likely to implement modern solutions in distribution ensuring their
distribution processes at the international level	competitiveness in the market
6 Pressure for Sustainable Development and	6 Competence and Quality of Management Personnel
Minimizing Carbon Footprint	o. competence and Quanty of Management Personner
The growing emphasis on sustainable development,	A highly qualified management team, capable of
including minimizing environmental impact, forces	making strategic decisions and effectively
operators to implement ecological innovations in	implementing technological innovations, is crucial for
distribution processes, such as electric vehicles or CO <sub>2</sub>	the success of innovation implementation in
emission optimization in routes.	distribution.
7. Impact of Changing Business Models and E-	7. Organizational Structure Efficiency
commerce	
The dynamic growth of e-commerce and the changing	An organizational structure that enables quick
business models, such as online sales, force logistics	decision-making and effective internal
operators to adapt to new market needs, including	communication supports the implementation of
improving the efficiency of distribution processes.	changing market conditions.

# 4. Evaluation of innovation implementation in the logistics sector based on empirical data

The study was conducted in January and February 2025. The entities selected for the research vary in size and scope of operation, with the common denominator being active participation in logistics processes either as a provider of these solutions or as a user of them. The research tool used to verify the questions and hypotheses was a questionnaire. It was decided to use the electronic CAWI (Computer-Assisted Web Interviewing) survey method, which allowed for the analysis of the studied issues from various perspectives, while also addressing multiple topics and providing the opportunity to reach a broad group of individuals from the surveyed population. A virtual version of the survey was created using Google Forms, containing 14 questions (4 demographic questions and 18 closed-ended substantive questions). As a result of the conducted study, responses were obtained from 100 respondents. The largest group of respondents (35.3%) are companies operating for more than 20 years. This may suggest that the industry being studied is dominated by stable, experienced enterprises that have survived various market challenges and have an established position. Companies operating for less than 5 years account for 30.4% of those surveyed. This indicates that there are many new entities in the market, which may suggest favorable conditions for starting a business but also high competition. Companies operating for 5-10 years account for 19.6%, and those operating for 10-20 years represent 14.7%, which is a relatively low result. This may suggest that some companies do not survive the first 10 years of operation or that the market is dominated by either young startups or long-established leaders. In the analyzed group, as many as 46.1% of companies declared activity in transportation. Warehousing (21.6%) and distribution (19.6%) are the next dominant areas of operation. Half of the surveyed companies (50%) employ fewer than 50 people, which may suggest that there are many small enterprises in the industry that do not require a large workforce. However, it should be noted that 21.6% of companies employ more than 1000 people, indicating that large organizations also play a key role. This may point to the presence of global or national logistics, manufacturing, or distribution leaders. The relatively low share of companies employing between 50-1000 people suggests that it is more difficult to grow in the category of medium-sized businesses in the studied sector. This may mean that smaller firms either remain small or are taken over by larger corporations. The transportation and logistics sector is highly diverse, ranging from small transport companies providing only transport services to large cross-border corporations offering a full range of contract logistics services.

One-third (33%) of the surveyed companies systematically introduce innovations in logistics processes. This indicates the innovative maturity of this group of enterprises and their constant pursuit of optimizing distribution logistics. The largest group of respondents (43.1%) indicates that nearly half of the companies see the need for innovation but do so sporadically.

This may be due to various reasons, such as lack of resources, technological knowledge, or the need for prior operational preparation. More than 15% of surveyed companies do not implement innovations systematically but have plans for such actions. This could mean that these companies are experimenting with modern solutions but do not consider them a key element of their strategy. The smallest group of companies declares that they do not implement innovations and have no such plans. This could indicate a conservative approach to distribution logistics or a lack of need for changes in the current system.

The most commonly used technologies are transport management systems (59.8%, 61 responses) – the most popular innovation, highlighting the importance of transport optimization in logistics, artificial intelligence and data analysis (41.2%, 42 responses) technologies related to processing and analyzing large datasets are gaining increasing popularity, and warehouse automation (29.4%, 30 responses) - used by almost one-third of companies, indicating a growing trend of automation in logistics processes. Other technologies mentioned by respondents include: Internet of Things (IoT) - 21.6% (22 responses), which helps in monitoring resources and optimizing processes, autonomous vehicles/drones -13.7% (14 responses), indicating slow adoption of these technologies, which may still be costly or experimental, and Blockchain - 8.8% (9 responses), a less commonly used technology but potentially applied in supply chain tracking. Companies primarily focus on optimizing transport, data analysis, and warehouse automation, which points to key areas of logistical transformation. The Internet of Things (IoT) and autonomous vehicles are less popular but still significant for the future of logistics. Blockchain is relatively rarely implemented, which may result from a lack of full understanding of its applications in the industry. Only 1% of respondents declare a lack of innovation, suggesting that almost all companies are taking steps towards technological development. The logistics sector is gradually adopting innovative technologies, but not all solutions are yet widely implemented. It can also be stated that the term "artificial intelligence" is not entirely understood – the solutions applied in the industry should rather be classified under the term "machine learning".

Rising operational costs represent the biggest challenge for companies, indicated by almost half of the respondents. This could be influenced by rising fuel, energy, labor costs, and inflation. A shortage of skilled workers (22.5%) is the second major issue, which may stem from recruitment difficulties and the need to invest in process automation. Issues related to global supply chains (10.8%), which may be impacted by disruptions in the delivery of raw materials and goods, delays, and rising transport costs, also pose a significant challenge for companies. Another factor influencing logistics problems is the rapidly changing customer preferences, highlighting the need for businesses to dynamically adjust their strategies to meet the changing market demands. The chart shows that companies must simultaneously deal with multiple challenges, with operational costs and the lack of skilled workers being the most pressing issues.

The study revealed that companies are responding to changing market challenges. The highest percentage of companies (45.1%) indicated that they have implemented process optimization actions. This suggests that, in the face of changing conditions, businesses are focusing on improving internal procedures to increase efficiency and reduce costs. The next two most commonly selected approaches (20.6% and 21.6%) show that companies are increasingly investing in modern solutions and collaborating with other entities to maintain competitiveness. A smaller emphasis is placed on the development of logistics services— only 10.8% of respondents identified logistics services development as a key adaptive strategy. This may suggest that companies consider other actions, such as process optimization and technology, to be more prioritized. A very small percentage of companies could not identify a specific strategy, which suggests that most organizations have a clear direction for adaptation. Also, only a small portion of respondents indicated that actions are being taken in all areas, which may mean that most companies are focusing on selected priorities. In summary, the survey results show that businesses are focusing on improving internal processes and technological innovations to meet market challenges.

87.3% of respondents (the sum of "very important" and "important" categories) consider logistics innovations an important element of competitiveness, which indicates the growing role of technology and process optimization in distribution. A small number of people regard this aspect as neutral or of little importance, suggesting that most companies recognize the need for changes and investments in this area. The lack of significant responses in the "insignificant" categories suggests that logistics innovations are seen as essential in today's business environment. In conclusion, the majority of respondents agree that innovations in distribution logistics play a key role in maintaining competitiveness in the market.

Only 26.5% of companies already have a dedicated logistics innovation department, indicating that most organizations do not yet have a formally separated unit focused on this issue. Over 43% of companies plan to create such a team, suggesting a growing awareness of the need for innovations in logistics. 30.4% of respondents believe it is not necessary, which may indicate that their companies either do not see the need for a dedicated department or manage logistics innovations in another way. The results show that although most companies recognize the importance of innovations in logistics (as indicated in previous charts), only a portion of them already have a dedicated team for this area. However, a large group of companies plans to establish one, indicating a trend toward greater specialization and investment in the logistics of the future.

Respondents also answered a question regarding the assessment of government or regional support for implementing innovations in the logistics sector. Respondents rated the support on a scale from 1 to 5, where 1 means no support and 5 means very high support. The most frequent response was a rating of 3 (neutral support), indicating a moderate perception of the level of support. A significant portion of respondents rated the support as 2 or 1, suggesting that many perceive it as insufficient. Only 6.9% rated the support as very high. Therefore, it should be

recognized that the expectations of the logistics industry are quite high, and most respondents assess the support for innovations in logistics as average or insufficient. Implementing innovations (especially technological ones) is, unfortunately, a process that requires significant financial investment as well as knowledge capital.

Technological innovations play a crucial role (also in terms of image) in enhancing the innovation of distribution logistics in organizations. The respondents indicated that technological innovations are of great importance (43.1%), although they are not a key factor. Meanwhile, 17.6% of respondents believe they are essential for efficiency. Only a small percentage (about 5%) stated that they have no impact. Analyzing the survey results, it can be observed that most respondents (60.7%, the sum of "Very important" and "Important" answers) consider technological innovations an important element for improving the efficiency of distribution logistics. This indicates a growing awareness of the role of modern technologies in optimizing logistics processes, reducing costs, and increasing productivity. Meanwhile, 25.5% of respondents attribute moderate importance to innovations, which may suggest that in their organizations, technologies do not yet play a central role, or their impact is limited to specific aspects of operations. A low percentage of respondents (8.8% - low importance, about 5% no importance) suggests that only a few organizations fail to recognize or implement modern technological solutions in distribution logistics. This could be due to various factors such as industry specifics, budget constraints, or lack of access to advanced tools. These results show that technological innovations play an increasingly important role in distribution logistics, and organizations recognize their potential to improve efficiency. This trend may indicate a growing need for investments in modern solutions, such as automation, artificial intelligence, or supply chain management systems.

The most frequently chosen innovation resulting from changing market conditions is warehouse process automation (44.1%). This demonstrates that organizations are striving to increase efficiency and reduce operating costs through automation, Warehouse Management Systems (WMS), and AI-based solutions in warehouse management. Digitalization and the use of Big Data (41.2%) are also significant, suggesting that companies are focusing on better collecting, analyzing, and utilizing data to optimize the supply chain and predict trends. Technologies supporting sustainable development (43.1%) are an important element of many companies' strategies, which may be linked to ESG (Environmental, Social, and Governance) regulations, reducing CO<sub>2</sub> emissions, and more eco-friendly transportation methods. Similarly, solutions in supply chain management (42.2%) indicate that organizations aim to increase the resilience of their supply chains, reduce the risk of delays, and improve logistical predictability. The implementation of resource-sharing platforms (13.7%) received significantly fewer responses. This may suggest that organizations are not yet ready for open collaboration models or do not see direct benefits in them. Only 1% of respondents indicated that innovation in logistics does not concern them. This means that virtually all companies recognize the need for change and modernization, even though the pace of implementing new technologies may differ between organizations. The analysis of results shows that companies are primarily investing in warehouse automation, digitalization, and supply chain optimization, which allows for greater flexibility and resilience to market changes. The increasing interest in sustainable development reflects adaptation to global ecological trends and regulations. At the same time, resource sharing is an area that is not yet highly popular. In the long term, it can be expected that further digitalization and automation will be key areas for the development of logistics, and organizations will increasingly implement solutions based on data analysis and AI to enhance their competitiveness in the market.

Most respondents also considered innovations to have a significant or very high impact on the organization's ability to respond to disruptions (a total of 62.7%). However, 32.4% rated the impact as moderate, and a small number of people indicated low or no impact. The results suggest that innovations in distribution logistics are an important factor in increasing the resilience of the supply chain, but they do not completely eliminate challenges related to disruptions.

As mentioned, innovations in distribution logistics increase an organization's competitiveness in the market, but their implementation is usually costly and involves necessary investments. The largest number of organizations declare moderate investments (40.2%), which suggests that although companies are investing in innovations, they are often constrained by budget or other priorities. A total of 39.2% of respondents (18.6% + 20.6%) indicated large or very large investments, which shows that for a significant group of companies, innovations are an essential element of their competitiveness strategy. 16.7% of companies invest little, which may indicate a focus on traditional logistics management methods. The lack of investment was not indicated by a significant number of respondents, suggesting that almost every organization allocates at least some resources to innovations. As many as 63.7% of respondents indicated the high cost of implementing technologies as the biggest obstacle. This shows that for many organizations, investing in logistics innovations is a costly venture, which may limit the pace of their implementation. 34.3% of companies struggle with a lack of qualified personnel, suggesting that the development of new technologies is outpacing the availability of specialists in the labor market. 30.4% pointed to a limited awareness of the benefits of innovations, meaning that some companies may not fully recognize the potential of modern solutions. 26.5% of companies lack adequate technological infrastructure, suggesting that a lack of modernization in other areas of the organization hinders the implementation of innovations. 22.5% of organizations face resistance from employees to change, which may stem from concerns about job losses or the need to learn new technologies. 17.6% pointed to a lack of support from management or company owners, indicating that not all organizations have a clear innovation strategy.

He most commonly identified innovation critical for distribution logistics is the automation of processes. This involves the implementation of modern technologies such as warehouse robots, automatic sorting systems, and autonomous transport vehicles. The goal of automation is to increase operational efficiency, reduce human errors, and lower costs. Advanced data analytics includes the use of Big Data, predictive algorithms, and machine learning to optimize logistics processes. It helps predict demand, better manage inventory, and streamline the supply chain. IoT in logistics refers to the use of smart sensors, real-time tracking systems, and intelligent RFID labels. It allows for monitoring transport conditions, cargo location, and optimization of resource management. Artificial intelligence supports decision automation, demand forecasting, delivery route optimization, and customer service chatbots. It can also increase warehouse efficiency by smartly managing space and resources. Digital platforms enable the integration of various supply chain participants (suppliers, carriers, distributors) on a single shared platform. They allow for better collaboration, order automation, and improved visibility of logistics processes. Supply chain optimization (26.5%) includes improvements in transportation management, warehousing, operational cost reduction, and increased delivery efficiency through better synchronization of processes.

The introduction of innovations is an obvious response to changes in the company's environment. The majority of organizations (44.1%) believe that market changes influence their decisions but do not lead to radical changes in strategy. At the same time, there is a division between companies that accelerate the implementation of innovations in response to changes (22.5%) and those that, due to difficult market conditions, limit investments in innovations (22.5%). Only a small part of organizations (8.8%) adjusts only in the case of significant changes, and only 2% of companies are completely resistant to market changes. These results indicate that most organizations maintain moderate flexibility regarding innovations, and only a part of them treats changing market conditions as the main factor determining their actions.

### 5. Summary

Innovations in distribution logistics are an inevitable development direction for the sector, driven by technological progress and changing market expectations. The research results confirm that investments in automation, digitization, and optimization of logistics processes contribute to increased efficiency and competitiveness of companies.

Distribution logistics has undergone dynamic transformations in recent years, due to both technological evolution and changes in consumer behavior. Modern solutions such as artificial intelligence, the Internet of Things, and blockchain are beginning to play an increasingly important role in optimizing logistics processes. Warehouse process automation and the implementation of intelligent transportation management systems enable more efficient and flexible delivery execution. The conducted research confirms that logistics operators recognize the importance of innovation, but face barriers to their implementation, such as high costs, lack of access to qualified workers, and limited institutional support.

One of the key conclusions from the analysis is the growing need to adapt operational models to the realities of digitization and automation. Logistics companies that effectively implement innovative technologies can not only increase their efficiency but also gain a competitive advantage in the face of increasing market pressure. On the other hand, failure to adapt to new realities may result in the loss of market position and limited expansion opportunities.

Further research in the field of logistics innovations should focus on analyzing the longterm effects of implementing modern solutions, as well as finding strategies to minimize implementation barriers. Special attention should be given to the impact of innovation on the social aspect, including changes in the labor market, the need for upskilling employees, and the impact on sustainable development and the reduction of  $CO_2$  emissions.

In conclusion, innovations in distribution logistics are a key element of the transformation of modern supply chains. Companies that actively invest in modern technologies and adapt their operational strategies to changing conditions have the opportunity to achieve long-term success and build a competitive advantage in the logistics sector.

## References

- 1. *Amazon Key, Amazon in garage,* https://www.amazon.com/Amazon-Key-In-Garage-Delivery/b?ie=UTF8&node=21222091011, January 5.2025.
- 2. Amazon Prime Air, https://www.aboutamazon.com/news/tag/prime-air
- Archutowska, A., Żbikowska, E. (2009). Rozwój rynku usług logistycznych w Polsce. In: D. Kisperska-Moroń, S. Krzyżniak (eds.), *Logistyka*. Poznań: Biblioteka Logistyka.
- 4. Bolumole, Y.A. (2001). The Supply Chain Role of Third-Party Logistics Providers. *The International Journal of Logistics Management*.
- Bowersox, D.J., Closs, D.J., Cooper, M.B. (2013). Supply Chain Logistics Management. McGraw-Hill.
- Brooks Bentz (2006). So You Think You Want to Outsource? *Logistics Today, May 9*, pp. 24-27, https://www.mhlnews.com/transportation-amp-distribution/so-you-think-you-want-outsource, December 12.2024.
- 7. Christopher, M. (2011). Logistics & Supply Chain Management. Pearson Education.
- 8. Ciesielski, M., Długosz, J. (2010). Strategie logistyczne. PWE.
- 9. Ciesielski, M. (2011). Logistyka w biznesie. PWE.
- CSCMP, https://cscmp.org/CSCMP/Educate/SCM\_Definitions\_and\_Glossary\_of\_Terms/ CSCMP/Educate/SCM\_Definitions\_and\_Glossary\_of\_Terms.aspx?hkey=60879588-f65f-4ab5-8c4b-6878815ef921, December 12.2024.

- DHL and Resilience 360, https://tapcrowdstatic-ie.s3-euwest1.amazonaws.com/5544/ confbagfiles/event/10890/CSI\_DHL\_Resilience360\_1474895712\_1507195876.pdf, January 05.2025.
- 12. Drucker, P.F. (1985). *Innovation and Entrepreneurship: Practice and Principles*. Harper & Row.
- 13. Emapa, https://emapa.pl/rozwiazania/#optymalizacja-tras, January 10.2025.
- Gołębska, E. (2009). Kompedium wiedzy o logistyce. In: D. Kisperska-Moroń, S. Krzyżniak (eds.), *Logistyka*. Biblioteka Logistyka.
- 15. Gudehus, T., Kotzab, H. (2012). Comprehensive Logistic. Springer.
- 16. Harrison, A., van Hoek, R. (2011). *Logistics Management and Strategy: Competing through the Supply Chain*. Pearson Education.
- 17. Hyperport, https://www.hyperlooptt.com/projects/hyperport/, January 05.2025.
- 18. Kisperska-Moroń, D., Krzyżaniak, S. (2009). Logistyka. ILiM.
- 19. Kotler, P. (2009). Marketing Management. Pearson Education.
- 20. Krawczyk, S. (2012). Outsourcing uslug logistycznych. Difin.
- 21. Langley, C.J. Jr., Allen, G.R. (2005). *Third-Party Logistics Study: Results and Findings of the 2005 TPL Study*. Georgia Institute of Technology.
- 22. Lieb, R.C., Randall, H.L. (1991, 1994, 1995, 1996). A Comparison of the Use of Third-Party Logistics Services by Large American Manufacturers. *Journal of Business Logistics*.
- 23. Mentzer, J.T., Flint, D.J., Hult, G.T.M. (2001). Logistics Service Quality as a Segment-Customized Process. *Journal of Marketing*.
- 24. Ostatnia Mila dla E-commerce Raport Polski Instytut Transportowy (2023). Otimo, Last Mile experts.
- 25. Reporting and Using Data on Innovation, 4th Edition. The Measurement of Scientific, Technological and Innovation Activities, by OECD/Eurostat: https://www.oecd.org/content/dam/oecd/en/publications/reports/2018/10/oslo-manual-2018 g1g9373b/9789264304604-en.pdf, January 20.2025.
- 26. Rogers, E.M. (1962). Diffusion of Innovations. Free Press.
- 27. Rydzkowski, W. (ed.) (2007). Usługi logistyczne. Poznań: ILiM.
- 28. Rydzkowski, W., Wojewódzka-Król, K. (2007). Transport. Logistyka. Ekonomia. PWN.
- 29. Schumpeter, J.A. (1934). The Theory of Economic Development. Harvard University Press.
- 30. Skjoett-Larsen, T. (2000). Third Party Logistics From an Interorganizational Point of View. *International Journal of Physical Distribution & Logistics Management*.
- 31. Skowronek, C., Sarjusz-Wolski, Z. (2012). Logistyka w przedsiębiorstwie. PWE.
- 32. Starship Technologies, https://www.starship.xyz/, January 05.2025.
- 33. Tompkins, J.A. (2006). The Business Imperative of Outsourcing. *Industrial Management, styczeń-luty*, pp. 8-12.
- 34. UPS Orion, https://www.supplychaindive.com/news/ups-orion-route-planning-analytics-data-logistics/601673/, January 05.2025.