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BARRIERS TO INNOVATION IN WAREHOUSE MANAGEMENT – CASE STUDY

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Purpose: The purpose of this paper is to identify and analyse the barriers to the implementation of innovation in a logistics service provider in the area of warehouse management.
Design/methodology/approach: The process of identifying and analysing barriers consisted of several stages. The first stage was a literature search to carry out a classification of innovations in logistics services and to develop a set of potential barriers to their implementation. The second and third stages were carried out through a case study. In the second stage, barriers to implementing lean projects were identified and analysed, while in the third stage, barriers to implementing other innovative projects were identified and analysed.
Findings: The result of the work is a set of barriers to the implementation of innovation in logistics services together with their relation to the type of innovation.
Research limitations/implications: The empirical research was based on a single case study. This organically represents the results obtained and does not allow them to be related to all logistics operators.
Practical implications: The research carried out provides recommendations on approaches to creating and implementing innovations for other logistics operators by inferring from the barriers that hindered the implementation of innovations.
Originality/value: This paper supports existing research on innovation in logistics services by building a set of barriers to their implementation. The focus of the research on innovation in warehousing services is justified by the contemporary demand for these services and also by the need for continuous improvement of warehousing services in supply chains.

Keywords: innovative logistics services, barriers to innovation implementation, logistics operator, logistics 4.0, warehouse management, smart warehouses.

Category of the paper: Research paper.

1. Introduction

Warehousing is the most visible process in the entire supply chain. In recent years, the demand for warehouse space in Poland has been growing and the warehouse market is facing the challenge of meeting the increasingly demanding needs of the customer and the end user. At the end of Q1 2023, the total stock of modern warehouse and industrial space in Poland approached the 30 million sq m mark, exceeding 29.9 million sq m, an increase of 19.3 per cent compared to the same period in 2022. New supply in the first three months of this year totalled more than 1.9 million sq m, the highest quarterly figure in the history of the Polish warehouse market, surpassing the previous record set in Q1 2022, when developers delivered 1.25 million sq m. At the end of March 2023, the volume of warehouse and industrial space under construction stood at 2.1 million sq m, 38% less than in Q4 2022 and more than 55% less than in Q1 2022 (Polski rynek…). At the same time, the development of new processes within the warehouse service such as co-packing, co-manufacturing and also the handling of e-commerce orders, which are supported by warehouse management systems, is observed.

Trends emerging in the TSL sector are prompting logistics companies, including logistics operators providing warehouse services, to implement modern solutions, the most eyecatching of which are the development of information and IT technologies and the desire to build cooperation with the customer and other companies on the market. The warehousing industry is dominated by the e-commerce sector. More and more companies are investing in the development of multi-channel services, a trend that poses new challenges for logistics companies operating such distribution systems.

Companies that want to be considered innovative will improve their processes by following these trends. Implementing innovation into a company involves overcoming many barriers based in the external environment (market, systemic/regulatory, technological, competence, financial), but also within the company (human, financial, technological/technical, structural).

Considering the challenges posed to logistics companies providing warehousing services and the problems of implementing innovation in logistics services, the focus of this paper is on identifying the barriers to the implementation of innovation by a logistics operator in the area of warehouse management. To this end, a literature study was conducted on innovation in warehouse management and the barriers to its implementation. This was followed by a case study of one logistics operator and analysed the innovations implemented in the period 2018-2022, identifying the reasons why innovative ideas were not implemented.

2. Process innovations in the warehouse management of logistics companies

2.1. Warehouse management of logistics companies - challenges

Logistics service providers in recent years have not limited their activities to simple transport, forwarding and warehousing services, but have developed their activities to include more complex services that create additional value for the customer through the synergy of many activities (Tunak, 2017). The role of the warehouse is therefore also changing and expanding to include additional activities and processes. There are seven main trends leading to the development of warehouse management (Fajczak-Kowalska, 2017):

- Changing the role of the worker from direct execution of operations to giving instructions and controlling the operation of equipment.
- Automation of processes to improve workflow and reduce costs.
- Introduction of information technology and mobile devices to improve the work and quality of operations.
- Development of Internet E-commerce sales and the associated adaptation of the warehouse to ship shipments to the individual customer.
- Ongoing access to stock-related information, e.g. stock levels.
- Improvement of planning systems.

These trends are superimposed on the growing needs reported by customers of logistics service providers (Winkelhaus, Grosse, 2020; Facchini et al., 2020, Richards, 2022):

- Customization and ancillary services including, for example, co-packing.
- High reliability of flows.
- Resistance to interference.
- Flexibility to respond to non-standard orders.
- Safety.
- Handling supply chains 4.0.
- Managing an increasing number of small shipments and fulfilling more frequent orders.
- Handling returns.

In addition, logistics organisations are being challenged with sustainable flows, green logistics of social responsibility.

There is a lot of competition in the 3PL logistics operators market, so the struggle is not only based on creating low prices, but also on undertaking diverse activities aimed at increasing one's position on the market (Bartczak, 2014). Companies offering end-to-end logistics services strive to create systems characterised by high complexity and uniqueness aimed at meeting customer requirements (Gąsowska, 2016).

In order to create a competitive advantage, service providers set themselves various economic, social and environmental goals to balance the development of the enterprise. In the case of companies with many customers, this process can be very complicated due to the diversity of customer requirements and, in the case of multinational companies with operations in different countries, e.g. legal regulations (Bąkowska-Morowska, 2015). To meet all these challenges, logistics companies need to improve both their transport and warehousing processes.

Both the warehouse infrastructure and the ways of managing all the processes in the warehouse, in response to the trends and challenges indicated, are constantly changing. Innovative technologies, the drive to automate every process occurring in the warehouse from reception, through storage, picking to the moment of withdrawal from the warehouse, guarantee new opportunities for companies, and innovative equipment allows warehouse solutions to be adapted in such a way as to ensure the highest possible benefit for the end customer.

Among the technological trends in warehouse management, the most frequently mentioned are (Simis, 2023):

- Wearable technologies - mobile devices that can be worn by the user and used to provide real-time insight into stock and availability data, support the execution of warehouse processes and optimise delivery and distribution processes.
- Augmented reality, which is used to optimise warehouse processes. The use of such a solution makes it possible to increase productivity by freeing the worker's hands and providing information about obstacles in the warehouse.
- Ability to access data on an ongoing basis - real-time access to inventory is a prerequisite for effective warehouse management.
- Three-dimensional (3D) space in the form of spatial visualisation of data, which allows for the optimisation of internal and external processes.
- Picking technologies, including voice and light picking technologies, which are being used by an increasing number of companies providing warehousing services. The solutions improve order preparation productivity and prevent picking errors.
- Identification of goods in logistics systems, including in particular the use of RFID technology and improvements in barcode technology (improved scanners and interfaces).

2.2. Types of innovation in the warehouse management of logistics companies

The definition of innovation according to J. Schumpeter (1934), where innovation is interpreted as the introduction of a new product or products with new properties to the market, the introduction of a new production method and a new technological process, the opening of a new market, the acquisition of new sources of raw materials, the carrying out of a new organisation of some industry, is characterised by a wide scope, referring to practically every field of activity of the enterprise. According to Pomykalski (2001), innovation is understood as a process covering all activities related to the creation of an idea, the creation of an invention, and then the implementation of a new or improved product, process or service. There are various interpretations of innovation (Pomykalski, 2001). Thus, in a narrow view, innovation can be equated with an invention that finds a specific application (Janasz, Kozioł, 2007). On the other hand, in a broader view, innovation is interpreted as a complex management process involving a variety of activities aimed at creating, developing and introducing new value in products, new combinations of means and resources (Białoń, 2012). In a broad sense, innovation also includes the transfer of these values to existing or new market partners, and may also be the result of collaboration between a group of companies (Oke, 2007). An important aspect of enterprise innovation is the implementation of such improvements that create new value from the customer's point of view, which in the case of logistics enterprises translates into changes in both the infrastructure and the processes themselves (Gąsowska, 2016). The innovation space in which a company operates has four dimensions (4Ps): product innovation, process innovation, positioning (position) innovation, paradigm innovation (Tidd, Bessant, 2011). The first two types can be defined as innovation in the traditional, narrower sense, while the last two types should be interpreted as innovation in the modern, broader sense. A product innovation is called a new or significantly changed product in terms of technical specifications, materials used, embedded software, etc. (Gąsowska, 2016). Process innovation refers to changes in product manufacturing methods and delivery methods, and includes technology, machinery, equipment and software. Although the definition of innovation varies, researchers point out that its intrinsic characteristic is novelty, which makes it an important determinant of development (Romanowska, 2016).

From a logistics point of view, innovation is expressed in the introduction of new logistics processes or services aimed at meeting customer needs (Cichosz, 2016). A logistics enterprise that manages innovation correctly therefore focuses on customer value, working with the customer in this respect and being future-oriented, which involves a process of continuous improvement and learning (Flint et al., 2005; Cichosz, 2016). Each type of innovation can be seen as radical or improving (Grawe et al., 2009; Cichosz, 2016) (Figure 1).

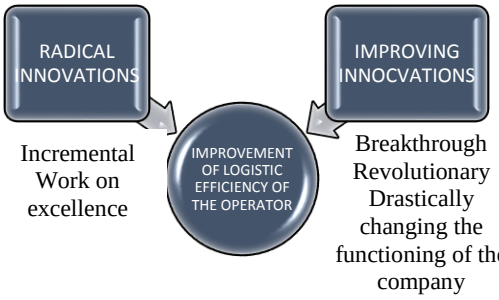


Figure 1. Breakdown of innovations by speed of change.

Source: own work based on Cichosz, 2016, p. 3.

Smart warehouses are the answer to the challenges posed to logistics operators. They must have an extensively developed information communication system and also have the capacity to efficiently manage warehouse resources by sensing the states both inside and outside the warehouse. This is possible thanks to the use of solutions that continuously control the operation of every system in the warehouse, from automated operations to communication systems between workers in the company and warehouse control systems such as ventilation, power supply to the warehouse, lighting or anti-theft systems (Zhen, Li, 2022).

Based on trends in warehouse logistics and the level of development of the technology currently used in warehouses, it is possible to create a picture of the warehouses of the future, which will use solutions geared towards (Richards, 2017):

- Eco-innovation, including modern energy supply technologies based on renewable energy sources, solutions supporting the development of flora and fauna ecosystems.
- Personalisation of the logistics service.
- Elimination of barriers to last mile transport.
- Omni-channel service with the same service standards across all channels.
- The use of machine learning, among other things, in handling returns and complaints.

Alongside automation, the most visible trend in warehouse development at the moment is digitalisation, i.e. scanning data, reducing it to information through machine processing, data transfer and the dissemination of knowledge online (Simic et al., 2023). Innovation can be applied at various levels, from the design of the warehouse itself to tools and warehouse management systems.

Industry 4.0 standards in warehousing refer to the use of modern technologies and solutions to automate warehouse processes and increase efficiency. Some of the more important Industry 4.0 standards in warehousing are:

- Interoperability: allows different systems and equipment in the warehouse to be easily interconnected, thus automating warehouse processes and increasing efficiency.
- Cyber security (Cheung et al., 2021): provides protection for data and storage systems against cyberattacks.
- Process transparency: makes it possible to track and analyse warehouse processes, thereby improving efficiency and service quality.
- Data analytics (Andiyappillai, 2019): allows data on warehouse processes to be collected and analysed for better warehouse management.
- Process automation: using industrial robots, automation systems and IoT to automate warehouse processes.

Robots, becoming faster and cheaper, are taking over repetitive warehouse processes such as picking and packing (Zhang, 2022). Typically, robots of this type are equipped with a gripping arm, a 3D scanner and a camera system for navigation through the warehouse, as well as additional software that is integrated with the internal WMS (Wang, 2022). An example of the use of automation solutions in the warehouse process is a mobile robot moving between racks. Robots are also the most effective tool to ensure the smooth circulation of goods between the receiving area, the storage area and the release area. Autonomus Mobile Robots (AMRs) are already being used in the warehouses of many companies. These machines are able to perform various tasks and move autonomously without interference. They provide greater precision and reliability and rapidly increase productivity (Hercik et al, 2022). Advanced automation and robotisation solutions can also be installed in picking vehicles. Equipped with software, sensors and laser scanners, the truck automatically recognises and tracks the operator, analysing the warehouse area, the operator's position, other people and obstacles in real time. The automation and robotisation of warehouse processes contributes to improved comfort and safety at work, makes it possible to work in a 3-shift system, increases efficiency, as well as reducing labour costs and increasing the competitiveness of the company Azadeh et al., 2019). The concept of Industry 4.0 is reflected in high-bay warehouses, which are an advanced form of warehouse automation, where the role of forklift operators is taken over by warehouse stacker cranes handling pallets on racks up to 40 metres high (Trzop, 2020). Another automated solution found in warehouses are Pick-by-Voice, Pick-by-Point, Pick-by-Light, etc. systems. Pick-by-HoloLens is a picking support system that uses interactive glasses. Using augmented reality, this system presents information to the worker about the products and where they are stored by means of a hologram (Cieśliński et al., 2022). Beacon technology is a micro-device, equipped with a Bluetooth Low Energy transmitter and appropriate software, which can be used in the order picking process and determine the fastest route for the trolley. Beacons can also support inventory work in the warehouse. These devices are relatively energy efficient, small in size and can communicate with almost any smartphone, tablet or laptop, allowing the construction of a network that supports a wide range of warehouse operations and fits in with the trends of the Internet of Things (Min, 2023). Also important in logistics 4.0 is

the concept of big data, which plays a key role in warehouse management for inventory management (Manyika et al., 2011). Big data analytics in warehouse logistics offers tangible benefits to companies that use the vacancy method or have implemented a cross-docking strategy for intra-warehouse cargo handling. In both cases, it leads to a more accurate planning of the assumed throughput and the resources needed for efficient warehouse processes. Big Data also improves the design of efficient routes in warehouses, minimising the fuel or energy consumption of forklifts, drones and other vehicles used in intra-warehouse transport. Most devices enabled by the Internet of Things do not have much in the way of data collection and processing capabilities, so the solution has become cloud computing, which is accessed simultaneously by personal (including mobile) devices with significant processing power (computers, tablets, smartphones) equipped with specialised applications (Sharma, Panda, 2023). The cloud is often the backbone of IT systems in many enterprises, and is the unifying factor between the technologies of the SMAC architecture: social networking (Social), mobile devices (Mobile), advanced analytics (Analytics) and cloud computing (Cloud). These elements enable the company to exploit synergies by communicating with each other. Cloud computing has gained an extension in the form of fog computing. Fog computing has bridged the gap between remote data resources accessible via the Cloud and Internet of Things devices, in industrial environments that generate large amounts of diverse data that must then be processed quickly. It provides internet-connected devices with a certain buffer of autonomy and the processes carried out with security (Szymczak, 2015). In this way, it is possible to design a comprehensive warehouse management system, integrating the functionality of an inventory management system and a warehouse management system (Ding, 2013). It provides the possibility of managing resources in real time, with detailed information about their quantity, type, date of production or expiry date; it also makes it possible to control storage conditions and analyse the efficiency of storage processes, such as reception, storage, packaging or issuing, carried out using automated internal transport devices, handling equipment, stacker cranes or robots. The solution can also be used to optimise storage space utilisation (Nowicka, Szymczak, 2020), stock rotation, duration of operations, damage and error rates.

2.3. Barriers to innovation

Rapid progress carries the risk of increasing barriers to the creation and implementation of innovations, resulting, for example, from a lack of necessary financial reserves or from a mismatch between the designed innovation and customer requirements. Another, most frequently repeated factor inhibiting the implementation of innovations is the human factor, i.e. the resistance/unwillingness of employees to change and the associated need to adapt to new working conditions (Fajczak-Kowalska, 2017).

Surveys conducted by the Central Statistical Office in 2012-2014 showed that about ¾ of enterprises from the industrial and service sector that did not implement innovative solutions into the enterprise cited as the main cause the lack of a sufficient reason to introduce innovation. The remaining ¼ of enterprises declared that they had thought about implementing innovative solutions but the barriers proved too difficult or impossible to overcome (Działalność innowacyjna…, 2015).

Barriers to innovation fall into two categories:

- External barriers that arise outside the company.
- Internal barriers that arise within the company implementing the innovation solution.

The barriers that may occur both before the start of an innovative project and during its implementation are presented in Table 1.

Table 1.
Potential Barriers occurring during the implementation of innovative solutions

External	Market	Low or uncertain market demand for innovative solutions
		Limited market for high-tech innovation in Poland
		Small number of customers trusting innovative solutions from Poland
	System/regulatory	Too many laws and regulations that are often subject to change and ambiguous in their interpretation
		Outdated legislation unsuited to a modern economy, not adapted to the development of innovation
		Lack of a long-term economic development concept for innovation activities,
		Lack of a system to foster the development of innovation knowledge in enterprises
		Lack of state and regional policy support for regional innovation systems.
		Support mechanisms too bureaucratic
		Underdeveloped regional innovation systems in Poland
		A system that provides limited support for innovation activity
	Technology	Insufficient development of innovative infrastructure
		Insufficient technology transfer
	Competence	Limited public administration support due to unfamiliarity and ambiguity of regulations and lack of business experience of people working in innovation centres.
		Misunderstanding of the strategic importance of innovation
	Financial	Difficulty or inability to raise funds for innovative activities due to the reluctance of banks to lend for such investments
		Lack of a funding system for innovative activities
		Overly complex credit procedures
		Bureaucracy involved in obtaining funding
		Investors focused on short-term investments
	Other	Lack of partnership approach on the part of the customer
		Customer disapproval
		Low level of trust between individuals

Cont. table 1.

Internal	Human	Employees' approach to implemented innovations	Employee and organisational opposition to change
			Fear of redundancy or redeployment
			Fear of changing job requirements
			Uncertainty about the future
			Risk of changes affecting the personal interests of some employees
			Misunderstanding of the changes being implemented
			The sense of loss associated with changes in the work process that affect the modification of social ties between employees.
			Perception of change as a lack of respect for the achievements of predecessors
			Employees' perception of the changes introduced as an unnecessary adjustment to a well-functioning process
		Creating innovative ideas	Failure to recognise development potentials/opportunities in the surroundings
			Lack of willingness to learn
			Not showing creativity for fear of criticism
			Low employee self-esteem
			Feeling uncertain about the usefulness of one's own ideas
			Perceiving one's actions as not useful
			Reluctance to take any action that might cause a disruption to the sense of stability (risk aversion)
			Sceptical approach to customer information
		Knowledge/ competences	Lack of management knowledge of company processes
			Lack of management awareness of opportunities to build competitive advantage through corporate innovation
			Lack of or inadequate pro-innovation management
			Lack of management competence in relation to innovative solutions
			Shortage or lack of staff qualified to implement innovative projects
			Lack of marketing knowledge and skills
			Lack of economic knowledge and skills
			Lack of knowledge or insufficient knowledge of the market
			Lack of knowledge or insufficient knowledge of new technologies
		Communication	The use of complex terminology, or terminology known only within a particular unit, that is not understood by all employees
			Failure to respect the stratification / levels present in the company in communication
	Financial		Significant costs of implementing innovations
			Too little profit for the company derived from the implementation of the innovation
			No dedicated innovation funding, innovation funding from profit only, innovation funding from profit only,
			Economic risks
			Lack of funds for employee training in connection with the implementation of innovations
	Technological/technical		Lack of adaptation of research and development units with adequate infrastructure
			Lack of infrastructure to implement innovative projects
	Structural		Lack of a unit responsible for research and development and the implementation of innovations
			An enterprise based on archaic organisational structures and outdated stereotypes of thinking
	Other		Too long a payback period
			Too much time needed for an innovation project
			Imposed time constraints on project implementation

Source: own work based on: Drozdowski, Zakrzewska, Puchalska, Morchat, Mroczkowska, 2010, pp. 113-114, 117-118; Penc, 2003, pp. 338; Cyran, 2016, pp. 204-205; Larsen, Lewis, 2007; Kraśnicka, 2013, pp. 165-179.

A company that is able to manage innovative projects in the right way can limit the emergence of barriers and, when they occur, reduce their impact on project implementation to a minimum. All innovations implemented in a company should be treated as a natural factor in building the company's advantage on the market (Penc, 2003).

3. Methodology

The barriers to innovation implementation identified in the literature research were analysed in a company providing logistics services. This company is an international logistics operator, which for more than 50 years has been offering a wide range of activities in the field of warehousing services extended by copacking, comanufacturing and e-commerce processes, transportation and distribution both domestically and internationally, as well as supply chain management for both manufacturing and distribution customers.

The offer of the warehousing service is based on the company's own network of storage and cross-docking points. The company offers the performance of basic warehousing processes (receiving, storage, picking, delivery) tailored to the requirements of the individual client, which can be extended to include additional services such as customised packaging, copacking and packaging of raw materials or semi-finished products into finished products (comanufacturing). The logistics facilities are equipped with advanced WMS warehouse management systems, which guarantee constant control over inventory, prevent errors and streamline all the processes taking place in the warehouse.

In order to best adapt its activities to the requirements of the market, the company is constantly expanding its storage areas through the construction of new facilities equipped with innovative solutions, cooperating in this respect with a company operating in the field of structural engineering.

The operator has more than a dozen storage points and transhipment hubs in Poland. Depending on the location, each of the logistics points serves a different market sector and therefore different brands are stored in each warehouse.

The empirical research, consisting of two stages, analysed the reported innovation ideas over a period of four years. The innovation ideas were classified according to the assumptions indicated in the literature research (research stage 1). Barriers to implementation were assigned to each innovation. The analysis was separated into projects that were a consequence of Lean implementation (research stage 2) and other innovation projects in warehouse management (research stage 3).

The logistics operator has introduced the Lean philosophy into the company. Most of the ideas implemented in the company are carried out on the basis of suggestions made by employees in the various warehouse departments and recorded on Lean boards distributed throughout the company. The ideas are divided into two types:

- Immediate action - the idea is implemented immediately by one or more people delegated to carry out the idea without appointing a working group.
- CI project (Continuous Improvement) - an idea requiring more extensive activities (investments, tests) by a working group assigned to this task. The realisation of the idea often requires contacts with other departments of the company, higher levels of the organisation's management as well as other divisions of the company, these projects often initiate the innovation activity of the company.

4. Research results

4.1. Analysis of barriers to implementing Lean ideas

Between 2018 and 2022, 608 ideas have been submitted for improvements to warehouse processes in nine departments located on the warehouse site. Each of the projects can be given one of four statuses during or after the project launch process:

- Rejected - idea rejected.
- Pending - an idea in the pipeline.
- Suspended - project implementation temporarily or completely suspended.
- Implemented - project completed.

The progress of each project is monitored on an ongoing basis and its status during the course may change.

Table 2 shows the breakdown of projects by assigned status taking into account the period from 2018 to June 2022. The largest number of ideas, 41.9% of the ideas from the entire analysed period were submitted in 2018. In each subsequent year, the number of ideas submitted under the Lean boards decreased. The largest decrease in the number of projects compared to the previous year occurred in 2019, with 116 fewer improvement ideas submitted in this period than in 2018. In the last year analysed, the number of ideas submitted accounted for only 3.6% of the total sum of the total number of projects, but this is due to the fact that only the period from January to June 2022 was taken into account.

Table 2.
Number of projects by status from 2018 to 2022

Year of application	Status				Total
	Implemented	Rejected	Suspended	Pending	
2018	135	110	10		255
2019	88	46	5		139
2020	53	49	8	4	114
2021	50	10	6	12	78
2022	14	1		7	22
Total	340	216	29	23	608

Source: Own work based on company materials.

The pie chart (Fig. 2) shows the percentage of the sum of the different statuses of the ideas during the period under analysis. More than half of the ideas proposed (55.9%) were implemented and more than one third of the ideas were rejected. The lowest percentage is represented by ideas in progress (3.8%) of which the majority (12) are ideas that started to be implemented in 2017, but it is worth noting that four of the problems proposed in 2016 with a pending status have not been solved so far. Considering the total number of ideas that did not live to see implementation (i.e. rejected and suspended), they represent 40.3 % of the total number of ideas submitted for implementation. The reasons for the rejection and suspension of ideas will be presented later in the analysis.

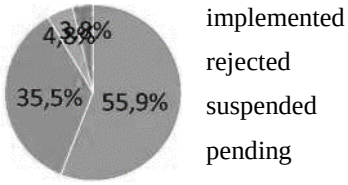


Figure 2. % share of each status in the total number of projects.

Source: Own work based on company materials.

Figure 2 provides a visualisation of the number of Lean ideas by assigned status considering the period from 2018 to June 2022.

Analysing the statuses by year, it can be seen that the highest number of ideas (39.7%) in the analysed period was implemented in the first year. From year to year, the number of ideas implemented at the logistics operator decreased. This situation is due to the fact that the number of areas in the company that require improvement is decreasing, which illustrates the fact that the company is achieving more and more specialised work and process excellence. In each year, the number of projects implemented exceeded the number of projects rejected. In 2020, 43.0% of the projects submitted were rejected, almost equalling this result with the number of projects implemented (46.5%). From 2021 onwards, there is a trend towards a decrease in the percentage of rejected projects in relation to the projects submitted in each year. In 2021, only 12.8% of ideas submitted were rejected and in 2018 - 4.5%.

In order to best identify the factors influencing the non-implementation of an idea, all projects in the rejected and suspended categories (245 ideas) were analysed and implementation barriers were identified on this basis. Table 3 shows a breakdown of the identified barriers by source of barrier formation and type of barrier, taking into account the number of individual barriers in each year. Taking into account the source of origin of the barriers, the sources were distinguished:

- External - barriers that do not result from the logistics operator's actions but come from outside the company.
- Internal - barriers that are the result of actions and decisions taken within the company.
- Other - these are not strictly barriers but rather other reasons for not implementing an idea.

Each of the 18 barriers originating outside the enterprise was assigned to one of seven types of barriers divided into legal barriers, health and safety barriers, barriers related to the availability of the product on the market and the customer of the logistics operator. Each of the 51 barriers originating from inside the enterprise was assigned to one of twelve barrier categories. For twenty-two projects (8%), insufficient data were obtained to identify barriers to implementing solutions into the enterprise (these ideas were categorised as other).

Table 3.
Barriers to implementing Lean projects in the warehouse management of a logistics operator

Source of barriers	Type of barrier	Barrier to implementation	year of application					Final total
			2018	2019	2020	2021	2022	
External	OHS	The solution will not increase safety or convenience of work		1				1
		A solution that does not comply with health and safety rules	1		1			2
	Decision-making - customer	Lack of acceptance of the project by the customer			2			2
		Failure to take action by the customer	1					1
		The customer does not need such a solution	1					1
		The customer does not agree with the solution	2	2				4
		Customer does not agree with solution - solution does not work	1					1
	Operation at the customer's premises	There is no possibility of solving the problem on the customer client side	1		1			2
		Problem solving on the customer side	1					1
	Customer communication	Limited communication with the customer	2					2
		Failed negotiations	1					1
	Legal	No possibility of amending the contract during its term			1			1
		HACCP regulations		1	1			2
		Solution rejected due to legal constraints	2					2
		Change in nationwide procedures	1					1
	Product	Lack of availability on the market of products with the required parameters			2			2
	Customer requirements	Solution applicable only to special benefits			1			1
		Solution not adapted to customer requirements	3	1				4
Internal	No proposal to solve the problem			1		1		2
	No project leader	No person willing to lead the project		1				1
	Temporary	Waiting too long to implement a solution	1	1		1		3
	Financial	No cost-effective solution - manual application equals automatic application	1					1
		Unviability of the solution due to lack of customer volume		1				1
		Too little savings from introducing a solution	2					2
		The cost of implementing the solution is too high	10	4	4	2		20
		Too high cost of introducing the solution, too low savings from introducing the solution			2			2
		Moving away from the old system - investing in changes to the old system generates unnecessary costs			1			1
	IT	Lack of features in the new version of the system	1	1				2
		Lack of adaptability of the system	4		1	1		6
		Solution rejected during testing, solution will not work					1	1

Cont. table 3.

	The introduction of the solution will negatively affect the implementation of processes	1					1
	Problem not solved	1					1
	No IT solution possible	4	5	4			13
	The introduction of the solution will adversely affect the operation of the system			1			1
Internal communication	Lack of decision-making on project implementation	1	1				2
	No response to project enquiry	3		1			4
	No response to project enquiries from individual departments	1					1
	Insufficient information to implement the project		1				1
	Unfamiliarity with the subject due to absence of the reporting employee		1	1			2
	Limited communication on project implementation	2	2	1	4		9
	A problem with the transfer of information between departments	1					1
Theft	Inability to implement the project due to risk of theft by outsiders			1			1
Solution rejected by vote	Solution rejected by the working group	1	3	4			8
	Solution rejected by superiors			1			1
	Solution rejected in staff vote	1	1	4			6
	Solution rejected at the meeting of the Company Social Benefits Fund	1					1
	Solution rejected by the HR department	1	1	1			3
Organisational	No solution possible	3	1	1			5
	Need to reorganise the warehouse				1		1
	Not viable due to elimination of the existing permanent solution	6	1	2			9
	Project not cost-effective with current configuration of process execution at warehouse	1		1			2
	The proposed solution adversely affects current processes	1	2				3
	The solution cannot be introduced during high activity	1					1
	The solution cannot be implemented in just one location - it must be implemented across the entire enterprise			1			1
	Resolving the problem by returning to the previous solution		1				1
	The introduction of a solution may result in a decrease in the process quality indicator			1			1
	The introduction of the solution may result in a disruption of the process	1					1
	The introduction of the solution may result in changes to the process standard	1					1
	Problem with traceability of several receptions on one document	1					1
	Implementation of the idea will negatively affect the flexibility of the warehouse		1				1
	The need to redefine process specifications within the organisation		1				1
Solution deemed insufficient		1					1
Echnical	Inability to match technical infrastructure	3					3
	Lack of adaptability of the solution to specific work tools		1				1
	No installation of the solution			1			1

Cont. table 3.

		No solution possible	2	2	3	2		9
		No solution for all types of products		1				1
		Project causes damage to storage infrastructure			1			1
		The proposed technical infrastructure has a shorter life cycle than that used to date		1				1
		Solution tested - does not work	2	1				3
	Ergonomics at work	Implementation of the project will worsen working conditions in terms of human physiological capacity			1			1
Other	Anomaly		3	1		1		5
	No data available		17	2	3			22
	Action taken in another project		15	8	6	1		30
	Incorrect execution of the process	Incorrect execution of actions in the system	1	1				2
		Failure to comply with standards	3					3
		Unfamiliarity with the process on the part of the employee				1		1
	Problem verified - unsubstantiated report (everything is working fine)		3	2	2			7
	Solution out of date	Introduction of a solution not justified due to customer abandonment	1					1
		Introduction of a solution not justified because the problem is time-barred				1		1
	Rare disruption		6	3				9
	Use of an alternative solution		8	1	4	1		14
Final total			134	60	63	17	1	275

Source: Own work based on company materials.

An analysis of the number of barriers in terms of the source of constraints on the implementation of ideas showed that 82.8% (5/6) of the barriers arise from within the company and only 1/6 of the ideas are not implemented by the influence of factors pushing from outside the company (Figure 3), indicating that in most cases it is the company's activities that influence the limited development of the logistics operator.

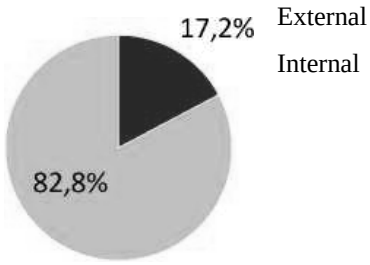
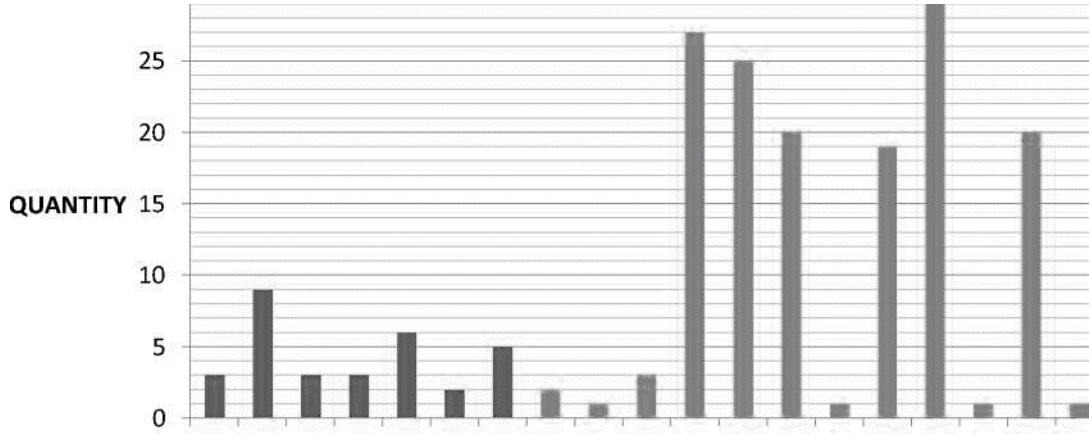


Figure 3. % share of individual sources of barriers in the total number of barriers identified.

Source: Own work based on company materials.

Analysing the number of different types of barriers in Figure 4 (the maroon colour indicates external barriers and the orange colour indicates internal barriers) illustrates which types of barriers most frequently influenced the rejection or suspension of an idea. The most common types of barriers are organisational (16.1%) followed by financial (15%), technical (11.1%) and those related to communication within the company (11.1%) and rejection of the idea (10.6%). All the above-mentioned types of barriers belong to the constraints arising within the company and they account for 7/9 of the reasons for project rejection. Reducing the impact of these

barriers on the implementation of ideas would significantly improve the implementation results achieved at the logistics operator.



In order: OHS, Decision making – customer, Operations on customer side, Communication – customer, Legal, Product, Customer's requirements, No proposal to solve the problem, No project leader, Time, Financial, IT, Internal communication, Theft, Rejected by voting, Organizational, Insufficient solution, Technical, Ergonomics work.

Figure 4. Barriers identified in the projects.

Source: Own work based on company materials.

A detailed study of the six most common types of barriers will be presented in the following section.

The number of organisational barriers decreased year on year. The highest number of organisational barriers occurred in Lean projects in 2018. The most common organisational barrier is rejection due to the unviability of the solution caused by the extinction of the legacy solution. It accounts for 40% of the organisational barriers that occurred in 2018 and 33.3% in 2020, and represents 31% over the entire period analysed. The most common reason for rejecting projects for organisational reasons in 2019 was the negative impact of the solution on the implementation of warehouse processes (28.6%). No organisational barriers were reported in 2022.

The highest number of financial barriers occurred in 2018 of which 76.9% was the too high cost of introducing the solution and it also represented the highest percentage of financial barriers recorded in the analysed period (74.1%). This barrier was recorded in every year between 2018 and 2021.The increase in the number of barriers compared to the previous year only occurred in 2020, where the number of barriers increased from 5 (in 2019) to 7 (in 2020). No financial barriers were recorded in 2022.

The number of IT barriers decreased year on year. The highest number of IT barriers occurred in 2018, with the highest percentage of barriers occurring in 2018 being the inability to implement a solution (36.4%) and the inability to fit an IT system (36.4%). Over the entire period analysed, the largest percentage was the barrier of not being able to implement a solution (52.0%).

The occurrence of fewer and fewer technical barriers was recorded each year. The highest number occurred in 2018 (7) and the lowest in 2021 (2). In 2022, no technical barriers were recorded as occurring. The largest percentage of such barriers was the inability to implement a solution for technical reasons. This barrier occurred in every year between 2018 and 2021 and in 2020 it accounted for as much as 60% of the technical barriers recorded in this period (tab. 4).

Of the most common types of barriers in Lean projects, only the category rejected by vote appeared more and more frequently between 2018 and 2020 as a factor determining the rejection of ideas. In the following years it did not occur at all. The number of barriers increased from 4 in 2018 to 10 in 2020, with the highest number of solutions rejected by the working group in the period analysed (42.1%).

Table 4.
Ratio of the number of projects submitted in a given year to the number of barriers

	Year of application				
	2018	**2019**	**2020**	**2021**	**2022**
Number of projects	255	139	114	78	22
Number of barriers	134	60	63	17	1
	52,5%	**43,2%**	**55,3%**	**21,8%**	**4,5%**

Source: Own work based on company materials.

4.2. Analysis of barriers to the implementation of other innovations in the logistics operator's warehouse management

Table 5 lists eight innovation projects that were proposed for implementation at the logistics operator but were not implemented. For each project, the potential benefits of implementing the solution are added, as well as the factors that determined the logistics operator's decision not to take action in this regard. Proposals for the first innovation projects were submitted in 2019 (three projects).

Table 5.
Description of innovation projects not implemented in the company

Solution	**Description of the solution**	**Potential benefits of implementing the solution**	**Reasons for non-implementation of the project**	**Year**
Drones	Drones used to implement the inventory process at the warehouse	• Reducing human labour • Accelerating process efficiency	• No verification of the number of boxes/pallets • Large discrepancies between the actual quantity stored and the system data • Warehouse space too limited	2019

Cont. table 5.

Loading platform Autodock	Equipped with a handling control system, the external platform automatically transports pallets in and out of the external means of transport dedicated to a specific company customer	• Exclusion of manual loading and unloading • Reducing the use of internal transport • Reduction in loading and unloading times by a factor of 6 (increase in productivity)	• Not applicable to all customers (adaptation of transport infrastructure) • Payback period too long (too few runs per shift) • The need to fit docks into the solution • Lack of decision-making on the part of the customer	2019
Inverter	Forklift truck-mounted pallet changer frontal e16	• Exclusion of manual repacking of damaged pallets or pallets with damaged goods • Reduction in process execution from 15-20 min to 2 min.	• No possibility of using in a dedicated storage area (does not work with liquid agents)	2019
Embedded scanner	Dual scanner built into the forks of the means of transport that automatically scans the label on the pallet	• Exclusion of label scanning • Reduced process times (increased productivity)	• High cost of purchasing the solution • Lack of adaptability of the system (system aimed at optimising the trucker's path, change of mission forces double scanning of the label) • An uneconomic solution due to lower human labour costs	2020
Suction pads	Surface vacuum gripping systems for handling components used in the picking of bulk packaging.	• Relieving human labour • Increasing productivity	• Inability to use the solution with a large variety of pack sizes	2020
Automation of copacking stations	Automation of processes previously performed manually by employees	• Increasing production efficiency • Relieving human labour	• Too much variability in the type of production in a short period of time • Lack of possibility to adapt the solution to each production order due to very low repeatability of orders	2020
Exoskeleton	A suit attached to the outside of a worker's body to support the work and strengthen the strength of the user's muscles during the picking of heavy packages.	• Relieving human labour • Increasing productivity	• High purchase cost of the solution • Too long a period of human adaptation to work in the suit • Impossibility to use the solution at the two planned warehouse locations due to differences in the type of work to be done and differences in the physical characteristics of the goods • Not suitable for work carried out in one position (too much stress on the knees)	2021

Cont. table 5.

Implementation of innovations e-commerce department	Application of innovative solutions for e-commerce combined with changes to the department's infrastructure	• Reducing lead times • Increasing productivity	• Too long a payback period (Too few orders executed) • Unprofitable investment - low income of the department	2021

Source: Own work based on company materials.

Each barrier occurring in innovation projects was classified according to the division introduced by the author in Lean projects. The number of barriers occurring in innovation projects is presented in Table 6. Seven types of barriers were identified, including six which have an internal source and one whose causes should be found in the company's environment. In eight projects, 20 barriers were identified leading to non-implementation of projects, of which the most frequent were lack of profitability of the solution (25% of the total number of barriers) and inability to apply the solution to all types of products (20% of the total number of barriers).

Table 6.
Barriers to the implementation of innovation projects in the warehouse management of a logistics operator

Source	Type of barrier	Barrier	year								Final total
			2019			2020			2021		
			Drones	Inverter	Loading platform Autodock	Automation of copacking stations	Suction pads	Embedded scanner	Exoskeleton	Innovation in the e-commerce	
Internal	Temporary	Waiting too long to implement a solution							1		1
	Ergonomics at work	Implementation of the project will worsen working conditions in terms of human physiological capacity							1		1
	Financial	Lack of cost-effectiveness of the solution	1		1	1		1		1	5
	Financial IT	The cost of implementing the solution is too high						1	1		2
		Lack of adaptability of the system						1			1
	IT	System errors	1								1
	Organisational	Need to reorganise the warehouse			1						1
	Organisational Technical	The new solution adversely affects existing processes	1								1
		Lack of capacity to access technical infrastructure	1								1
	Technical customer	No solution for all types of products		1		1	1		1		4
		Need to adapt transport infrastructure			1						1
External	Customer	Lack of acceptance by the customer			1						1
Final total			4	1	4	2	1	3	4	1	20

Source: Own work based on company materials.

Analysing the sources of barriers to the implementation of innovation projects in the company based on data for eight innovation projects, it can be seen that more than 90% of the barriers arise inside the company

Technical barriers in 2019 were present in every innovation project planned at that time, in 2020 they were identified in two projects and in 2021 in one project. As for financial barriers, their number increased from one in 2019 to 3 in 2020 and 2021 and they were mainly due to the lack of profitability of implementing the innovative solution.

Figure 5 shows the percentage share of each type of barrier in the innovation projects analysed. The highest percentage are financial barriers (35%) followed by technical barriers (30%). IT and organisational barriers account for 10% of barriers each and the least common barriers are those related to work ergonomics, customer decision-making and time.

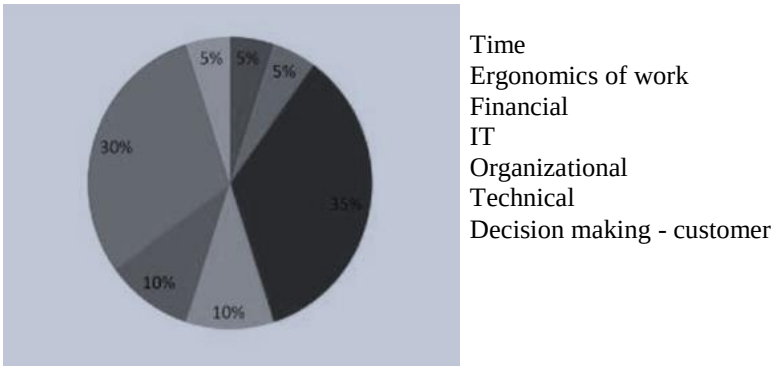


Figure 5. Percentage share of each type of barrier in innovation projects in the total number of barriers identified.

Source: Own work based on company materials.

Analysing the two most frequent types of barriers in innovation projects (financial and technical), it can be observed that the most frequent barrier for the implementation of innovation projects is the lack of profitability of the solution (20%), followed by the lack of possibility to apply the solution to all types of products (20%). The third most frequent barrier is too high cost of introducing the solution. The rest of the barriers occurred in equal amounts (Figure 6).

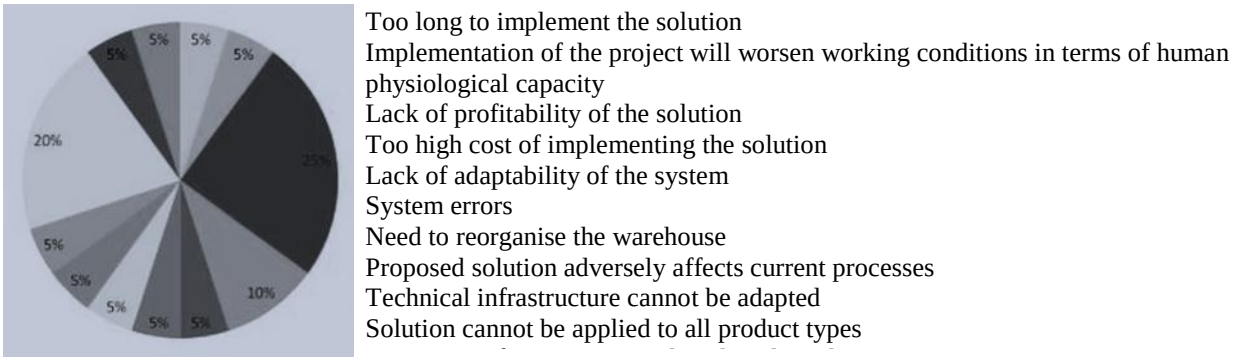


Figure 6. % share of individual financial and technical barriers.

Source: Own work based on company materials.

Innovation activities in the company are more limited by the unprofitability of the solution than by the too high cost of the solution, which indicates that the operator wants to invest in modern solutions. A major constraint is that the solution is not versatile enough, making the application of innovation uneconomic due to the limited field of application of automation. This is a serious problem, as many of the ideas analysed were driven by the specific needs of the customer served. According to the literature research, it is the customer and its needs that are the main source of innovative ideas.

Personalisation of the logistics service, on the other hand, determines that a solution created for a specific customer will not be applicable to serving another customer. Investment in this type of innovation is therefore associated with high risk. This risk is not mentioned in the research to date on the barriers to the implementation of innovation in companies providing logistics services.

5. Conclusion

The contemporary interest in the issue of service innovation stems from the need for modern companies to build a competitive advantage, the sources of which are currently increasingly seen in service activities. Research on service innovation depends on the level of analysis adopted. They may concern the economic importance of innovation (macroeconomic approach) or the importance of service innovation within the boundaries of the enterprise (microeconomic approach).

On the basis of the research carried out, it can be concluded that the impetus for innovation in logistics companies is the changing needs of customers, especially in the area of additional services. Logistics service providers in recent years have been developing their activities with more complex services that create additional value for the customer through the synergy of many activities. Taking into account the entire TSL industry, a large number of modern, innovative solutions can be observed, which are applied during service provision and sometimes interdependent.

Introducing innovative solutions into an enterprise involves encountering a wide variety of obstacles and overcoming implementation barriers ranging from financial constraints to the human factor, i.e. employee resistance/unwillingness to change and the associated need to adapt to new working conditions, which are identified and classified in the paper.

The logistics operator included in the case study achieves a high market position by taking action based on continuous improvement of the entire company based on the Lean Management philosophy and managing the creation and adaptation of innovations.

Based on the analysis of 608 Lean Management ideas covering the years 2018-2022, it was noted that more than half of the ideas submitted (55.9 per cent) in the years analysed were implemented in the company, confirming that the operator is undertaking increased continuous improvement activities in the company. Considering the total number of ideas that did not live to be implemented (i.e. rejected and suspended), they represent 40.3% of the total number of ideas submitted for implementation. The lowest percentage is accounted for by pending ideas (3.8%), the majority of which (12) are ideas that started to be implemented in 2017, but it is worth noting that four of the problems reported in 2016 with a pending status have not been resolved to date, illustrating the limitations of the company as regards the implementation of some employee ideas.

However, when analysing the 245 projects with rejected and suspended status, 18 barriers originating outside the company (17.2% of all identified barriers) and 51 barriers originating inside the company (82.8% of all identified barriers) were identified, which indicates that in most cases it is the company's activity that influences the limited development of the logistics operator. The most common types of internal barriers are organisational and financial. The most common barrier in Lean projects is the too high cost of implementing the solution.

Analysing the 8 innovative projects that have not been implemented in the logistics company between 2019 and 2021, it was noted that more than 90% of the constraints preventing project implementation are to be found in the internal activities of the company. The most common types of barriers occurring limiting the implementation of innovation projects are financial and technical barriers (these account for more than half of all types of innovation project barriers), in particular the lack of profitability of the solution (25% of the number of all barriers) this occurs in four out of eight projects and the inability to apply the solution to all types of products (20% of the number of all barriers) this occurs in four out of eight projects.

Given that in the analysed logistics company, innovation management is strictly linked to the company's activities in terms of Lean Management philosophy, the focus should be on eliminating the most common barriers in both areas of the company's activities, in particular financial, organisational and technical barriers. Reducing the impact of these barriers on the implementation of ideas would significantly improve the implementation performance of the logistics operator and further increase the innovation level of the enterprise.

One case study was included in the paper, which was dictated by the granularity of the analyses conducted, however, this is a limitation of the research as the results obtained cannot be generalised to other logistics operators. It is therefore worth extending the research to other logistics enterprises in further stages of the study, which will allow an analysis of the relationship between the type of innovation and the barriers to its implementation to be carried out.

References

1. Andiyappillai, N. (2019). Data Analytics in Warehouse Management Systems (WMS) Implementations. *International Journal of Computer Applications, Vol. 181, No. 47,* pp. 14-17.
2. Azadeh, K., De Koster, R., Roy, D. (2019). Robotized and automated warehouse systems: review and recent developments. *Transportation Science, Vol. 53, Iss. 4,* pp. 917-945.
3. Bąkowska-Morawska, U., Witkowski, J. (2015). Kulturowe uwarunkowania zarządzania łańcuchem dostaw w Japonii, Polsce i Wielkiej Brytanii. *Organizacja i Kierowanie, Vol. 4,* pp. 39-54.
4. Bartczak, L. (2014). Innowacyjność jako wyzwanie podjęte przez operatorów 3PL. *Logistyka, Vol. 3,* pp. 55-65.
5. Białoń, L. (2012). Zarządzanie działalnością innowacyjną. Warszawa: Placet, pp. 14-16.
6. Cheung, K., Bell, M., Bhattacharjya, J. (2021). Cybersecurity in logistics and supply chain management: An overview and future research directions. *Transportation Research Part E: Logistics and Transportation Review, Vol. 146.*
7. Cichosz, M. (2016). Proces innowacji w relacjach operatorów logistycznych z klientami. *Gospodarka Materiałowa i Logistyka, Vol. 6,* pp. 1-15.
8. Cieśliński, W., Perechuda, K., Szewc, W. (2022). Model organizacji 4.0 – w kierunku algorytmizacji zarządzania. In: R. Knosala (ed.), *Inżynieria zarządzania, Cyfryzacja produkcji, Aktualności badawcze, 4.* Warszawa: PWE, p. 411.
9. Cyran, K. (2016). Ograniczenia wdrażania działań innowacyjnych w sektorze małych i średnich przedsiębiorstw. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach No. 276,* pp. 204-205.
10. Ding, W. (2013). Study of Smart Warehouse Management System Based on the IOT. In: Z. Du (ed.), *Intelligence Computation and Evolutionary Computation*. Berlin-Heidelberg.
11. Drozdowski, R., Zakrzewska, A., Puchalska, K., Morchat, M., Mroczkowska, D. (2010). *Wspieranie postaw proinnowacyjnych przez wzmacnianie kreatywności jednostki*. Warszawa: PARP.
12. *Działalność innowacyjna przedsiębiorstw w latach 2012-2014* (2015). Raport. Warszawa: GUS, pp. 119-122.
13. Facchini, F., Oleśków-Szłapka, J., Ranieri, L., Urbinati, A. (2020). A Maturity Model for Logistics 4.0: An Empirical Analysis and a Roadmap for Future Research. *Sustainability, Vol. 12, No. 86,* pp. 2-18.
14. Fajczak-Kowalska, A. (2017). Innowacyjne rozwiązania w logistyce magazynowej. *Logistyka, Vol. 4,* p. 33.

15. Flint, D.J., Larsson, E., Gammelgaard, B., Mentzer, J.T. (2005), Logistics innovation: A customer-Value Oriented Process. *Journal of Business Logistics, Vol. 26, No. 1*, pp. 113-147.
16. Gąsowska, M. (2016). Kształtowanie przewagi konkurencyjnej przedsiębiorstwa świadczącego usługi logistyczne. *Gospodarka Materiałowa i Logistyka, Vol. 10*, pp. 25-32.
17. Grawe, S.J., Chen, H., Daugherty, P.J. (2009). The relationship between strategic orientation, service innovation, and performance. *International Journal of Physical Distribution and Logistics Management, vol. 39, no. 4*, pp. 282-300.
18. Hamdy, W., Mostafa, N., Elawady, H. (2018). *Towards a smart warehouse management system.* Proceedings of the International Conference on Industrial Engineering and Operations Management Washington DC, USA, September 27-29.
19. Hercik, R., Byrtus, R., Jaros, R., Koziorek, J. (2022). Implementation of Autonomous Mobile Robot in Smart Factory. *Applied Science, Vol. 12*, pp. 1-18.
20. https://www.sciencedirect.com/science/article/abs/pii/S1366554520308590?via%3Dihub.
21. Janasz, W., Kozioł, K. (2007). *Determinanty działalności innowacyjnej przedsiębiorstw*. Warszawa: PWE.
22. Kamali, A. (2019). Smart Warehouse vs. Traditional Warehouse – Review. *CiiT International Journal of Automation and Autonomous System, Vol. 11, No. 1*, pp. 9-16.
23. Kraśnicka, T. (2013). *Innowacyjność przedsiębiorstw – uwarunkowania organizacyjne*. Katowice: Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach.
24. Larsen, P., Lewis, A. (2007). How Award-Winning SMEs Manage the Barriers to Innovation. *Creativity and Innovation Management, Vol. 16, No. 2*, pp. 34-45.
25. Manyika, J. et al. (2011). *Big data: The next frontier for innovation, competition, and productivity.* San Francisco, pp. 1-143.
26. Min, H. (2023). Smart Warehousing as a Wave of the Future. *Logistics, Vol. 7, No. 30*, pp. 1-12.
27. Nowicka, K., Szymczak, M. (2020). Logistyka i łańcuchy dostaw w obliczu czwartej rewolucji przemysłowej. *Studia BAS, Vol. 3, No. 63*, pp. 61-84. https://doi.org/10.31268/StudiaBAS.2020.22.
28. Oke, A. (2007). Innovation types and innovation management practices in service companies. *International Journal of Operations & Production Management, Vol. 27, No. 6*, pp. 564-587.
29. Okoń-Horodeńska, E. (ed.) (2004). *Rola polskiej nauki we wzroście innowacyjności gospodarki.* Warszawa: PTE.
30. Penc, J. (2003). *Strategiczny system zarządzania*. Warszawa: Placet.
31. Piecyk, M., Björklund, M. (2015). Logistics service providers and corporate social responsibility: sustainability reporting In the logistics industry. *International Journal of Physical Distribution & Logitics Management, Vol. 45, No. 5*, pp. 459-485.
32. *Polski rynek magazynowy w I kw. 2023 r.* (2023). Raport. Warszawa: GUS.

33. Pomykalski, A. (2001). *Zarządzanie innowacjami*. Warszawa: PWN.
34. Rejman, K. (2007). Wpływ innowacyjności na efektywność współczesnych przedsiębiorstw. *Przedsiębiorczość - edukacja, Vol. 3*, pp. 220-224.
35. Richards, G. (2022). *Zarządzanie logistyką magazynową*. Warszawa: PWN.
36. Romanowska, M. (2016). Determinanty innowacyjności polskich przedsiębiorstw. *Przegląd Organizacji, Vol. 2,* pp. 29-35.
37. Schumpeter, J.A. (1934). *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle*. Cambridge, Massachusetts: Harvard University Press.
38. Sharma, P., Panda, S. (2023). Cloud Computing for Supply Chain Management and Warehouse Automation: A Case Study of Azure Cloud. *International Journal of Smart Sensor and Adhoc Network, Vol. 3, No. 4,* pp.19-29.
39. Simic, V., Dabic-Miletic, S., Tirkolaee, E., Stevie, Z., Ala, A., Amirteimoori, A. (2023). Neutrosophic LOPCOW-ARAS model for prioritizing industry 4.0-based material handling technologies in smart and sustainable warehouse management systems. *Applied Soft Computing, Vol 143, C*. Online publication date: 1-Aug-2023.
40. Szymczak, M. (2015). *Ewolucja łańcuchów dostaw*. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.
41. Tidd, J., Bessant, J. (2011). *Zarządzanie innowacjami*. Warszawa: PWN.
42. Trzop, A. (2020). Przegląd rozwiązań z zakresu przemysłu 4.0. stosowanych w obszarze logistyki. *Zeszyty Naukowe Politechniki Poznańskiej seria Organizacja i Zarządzanie, vol. 81*, pp. 233-247.
43. Tunak, B. (2017). Kluczowe czynniki sukcesu usługodawców logistycznych w świetle zmian zachodzących na rynku TSL. *Gospodarka Materiałowa i Logistyka, Vol. 8,* pp. 14-15.
44. Wang, K., Hu, T., Wang, Z., Xiang Y., Shao, J., Xiang X. (2022). Performance evaluation of a robotic mobile fulfillment system with multiple picking stations under zoning policy. *Computers and Industrial Engineering, vol. 169, C*. Online publication date: 1-Jul-2022.
45. Winkelhaus, S., Grosse, E. (2020). Logistics 4.0: a systematic review towards a new logistics system. *International Journal of Production Research, Vol. 58, No. 1,* pp. 18-43.
46. Zhang, S., Zhuge, D., Tan, Z., Zhen, L. (2022). Order picking optimization in a robotic mobile fulfillment system. *Expert Systems with Applications: An International Journal, Vol. 209, C.* Online publication date: 15-Dec-2022.
47. Zhen, L., Li, H. (2022). A literature review of smart warehouse operations management. *Front. Eng. Manag., Vol. 9, No. 1*, pp. 31-55.