IBIMA Publishing
Communications of International Proceedings
https://ibimapublishing.com/p-articles/47ISM/2026/4724026/
Vol. 2026 (7), Article ID 4724026

Areas of Potential Implementation of Artificial Intelligence in Warehouse Management Systems: Insights from West Pomeranian Voivodeship of Poland*

Ludmiła FILINA-DAWIDOWICZ and Dorota CIESIELCZYK

West Pomeranian University of Technology in Szczecin, Faculty of Maritime Technology and Transport, Piastów Avenue 41, 71-065 Szczecin, Poland

Correspondence should be addressed to: Ludmiła FILINA-DAWIDOWICZ, ludmila.filina@zut.edu.pl

*Presented at the 47th IBIMA International Conference, 29-30 June 2026, Madrid, Spain

Abstract

The development of information technologies plays a crucial role in enhancing the operational efficiency of logistics processes and strengthening the competitive position of enterprises operating within supply chains. As digital transformation accelerates across industries, the implementation of Warehouse Management Systems (WMS) becomes increasingly vital for companies seeking to optimize inventory control, streamline warehouse operations, and improve customer service. Moreover, the development of artificial intelligence (AI) opens new possibilities for its implementation in WMS. The aim of this article is to examine the benefits and barriers for the development of WMS in enterprises operating in the West Pomeranian Voivodeship of Poland, as well as identify potential areas, benefits and concerns of AI implementation in WMS, considering practitioners viewpoint. The study is based on a questionnaire survey developed and conducted among representatives of companies from the West Pomeranian Voivodeship of Poland. It was stated that among the most significant benefits that enterprises can achieve through the development of WMS are reduction of human error, process automation, and decrease in order processing times. The most significant barriers to further WMS development include high implementation costs, integration complexity, and insufficient awareness of system capabilities among warehouse management staff. Respondents identified the highest potential of AI application in WMS in analytical and decision-support areas, particularly demand forecasting, inventory optimization, and reporting. Among the benefits of AI implementation in WMS, practitioners highlighted the automation of routine processes, improved demand forecasting and increased operational accuracy. In turn, concerns are mostly related to high investment costs and risk of job losses.

Keywords: warehouse management systems (WMS), artificial intelligence (AI), digital transformation, supply chain.

Introduction

Contemporary companies operating in a dynamic, competitive, and increasingly digitized market environment face constant pressure to enhance operational efficiency, reduce logistics costs, and respond swiftly to evolving customers' expectations (Ilandarage, 2025). Hence, warehouse processes optimization forms one of the most important trends in supply chains development. Modern warehouses are no longer solely storage facilities but central nodes of integrated supply chains, where information flows are as important as physical flows of goods (Shanmugamani & Mohamad, 2023; Berkers et al., 2021).

Warehouse Management Systems (WMS) are among the key tools driving digital transformation of logistics companies, as they enable accurate inventory control, increase the transparency of internal logistics processes, improve overall service performance and decision-making quality (Ilandarage, 2025). Available research results

Cite this Article as: Ludmiła FILINA-DAWIDOWICZ and Dorota CIESIELCZYK Vol. 2026 (7) " Areas of Potential Implementation of Artificial Intelligence in Warehouse Management Systems: Insights from West Pomeranian Voivodeship of Poland " Communications of International Proceedings, Vol. 2026 (7), Article ID 4724026, https://doi.org/10.5171/2026.4724026

indicate that WMS can significantly enhance warehouse productivity, reduce picking errors, optimize space utilization, and strengthen collaboration across the supply chain (Shanmugamani & Mohamad, 2023; Berkers et al., 2021). Moreover, the integration of WMS with other systems, such as Enterprise Resource Planning (ERP), Transportation Management System, as well as automated material handling equipment, facilitates development of more resilient and flexible logistics structures (Minashkina & Happonen, 2023). In addition, the process of selecting or developing WMS relies on strategic considerations, including sustainability objectives, system scalability, and the ability to respond to future operational needs (Minashkina & Happonen, 2020).

However, the effective implementation and development of WMS depend not only on technological factors, but also on a broader range of internal and external conditions. These include, i.e. (Fechner, 2009):

- the level of technological infrastructure and digital maturity of companies,
- the size and industry profile of enterprises, which influence warehouse complexity and information technology (IT) adoption potential,
- the availability of qualified personnel, particularly specialists capable of configuring and managing advanced logistics systems,
- institutional, regulatory, and economic conditions, shaping the broader environment for technological innovation in the region.

WMS are constantly developed and adjusted to customers' needs. In recent years, the growing interest in the use of artificial intelligence (AI) technology in improving warehouse management was observed (Dewy et al., 2025). Al-driven models enhance key warehouse tasks such as inventory management, order picking, routing, and resource allocation (Obeidat & Puiul, 2024). However, implementing AI technologies deals with the number of challenges that should be considered (Dabic-Miletic, 2024; Dyczkowska et al. 2025).

Based on conducted review of available literature it could be stated that implementation of IT systems in transport and logistics companies point to significant differences in the level of digital readiness among enterprises and their ability to implement advanced logistics solutions (Filina-Dawidowicz et al., 2025a; Filina-Dawidowicz et al. 2025b). Moreover, practitioners' viewpoint on AI implementation in WMS by companies located in particular regions of Poland was not analysed in detail.

The aim of this article is to examine the benefits and barriers for the development of WMS in enterprises operating in the West Pomeranian Voivodeship of Poland, as well as identify potential areas, benefits and concerns of AI implementation in WMS, considering practitioners' viewpoint. The research focuses on identifying practitioners' viewpoint on aspects that affect the implementation and development of WMS. Understanding the attitude to changes introduced in WMS taking into account experts opinions coming from particular region is crucial for both software suppliers and business entities involved in managing warehouse processes.

Literature Review

The dynamic expansion of digital technologies and the increasing requirements of logistics companies' customers impacted the development of WMS (Filina-Dawidowicz et al. 2025a). These systems are implemented in warehouses to manage and improve warehouses operations, including loading and unloading, conditioning, packing, marking, provisioning and other (Sied, 2024). WMS have a wide spectrum of functionalities, such as inventory control, warehouse location management, support for order picking and dispatch processes (Atieh et al., 2016). Selected areas of warehouses activities supported by WMS are shown in Table 1.

Table 1: Selected areas of warehouses activities supported by Warehouse Management Systems (own elaboration based on Sied, 2024; Ilandarage, 2025)

Area	Description
Management of warehouse resources and warehouse staff operations	Planning, organizing, and supervising warehouse resources, including equipment, space, and personnel, in order to ensure efficient, safe, and cost-effective warehouse operations
Picking and packing	Organizing and executing the accurate picking of goods from storage locations and packing them according to customer orders, transport requirements, and quality standards

Receiving and dispatching goods to/from the warehouse	Managing the receipt of inbound goods and the dispatch of outbound shipments, including verification of quantities, quality checks, and coordination with transport providers
Handling of complaints and returns	Processing customer complaints and returned goods by identifying causes, ensuring proper documentation, and coordinating corrective actions and replacements when necessary
Monitoring of stock levels	Continuous control and analysis of inventory levels to prevent stock shortages or overstocking and to support effective replenishment and planning decisions
Preparing documentation and reports	Creating and maintaining operational documentation, inventory records, and performance reports to support internal management and external compliance requirements
Conducting an inventory	Performing regular and ad hoc inventory counts to verify physical stock against system records and to identify discrepancies or losses
Managing the location of goods and their flow within the warehouse	Organizing storage locations and controlling internal material flows to optimize space utilization, accessibility, and order fulfilment efficiency
Management of packaging and logistics units	Controlling the availability, use, and circulation of packaging materials and logistics units such as pallets, containers, and reusable carriers

The implementation of WMS in companies is a complex process that depends on a range of internal and external factors. Fechner (2009) emphasized that the development of warehouse infrastructure is influenced by both economic conditions and the institutional environment of a given region. Organizational maturity and workforce competences should be also considered for the effective implementation of WMS (Kłodawski et al., 2017). From the perspective of enterprises, the effective implementation, use, and further development of WMS are primarily determined by the following factors (Andiyappillai, 2023):

- the level of technological infrastructure,
- the availability of qualified personnel,
- the scale of operations and industry profile of the enterprise,
- organizational readiness for change.

Implementation of WMS in companies involved in supply chains deals with the number of benefits and concerns (Shanmugamani & Mohamad, 2023; Berkers et al., 2021). On the one hand, the improvement of warehouse processes, reduction of errors number is expected by companies managers (Shanmugamani & Mohamad, 2023). On the other hand, the financial constraints, a lack of specialized knowledge, and insufficient institutional support could impact innovations implementation (Kramarz, 2023).

Currently, WMS are becoming increasingly intelligent and advanced, based on data analytics, and integration with Industry 4.0 technologies, which significantly increase their potential for processes optimization (Zhang et al., 2025). At the same time, growing interest in implementation of systems supporting workforce management in warehouses, particularly in the context of increasing operational complexity and the need to improve labour efficiency in these facilities can be observed (Kellermayr-Scheucher et al., 2023). Modern WMS serve not only as tools supporting basic warehouse operations, but also as platforms integrating processes, data, and participants of supply chains (Filina-Dawidowicz et al., 2024).

Kalinowski et al. (2024) highlighted that contemporary WMS are shifting from traditional process-based management toward an activity-focused approach, enabling a more precise representation of real material flows under changing operational conditions. At the same time, predictive modules supporting warehouse resource planning are increasingly being incorporated into these systems (Jomaa et al., 2013). Moreover, WMS development is directed toward highly integrated systems capable of cooperating with advanced automation solutions and analytical platforms (European Business Review, 2024). Minashkina and Happonen (2023) demonstrated that the effectiveness of WMS utilization largely depends on the level of integration of information systems across the entire supply chain, particularly in third-party logistics (3PL) companies.

Warehouse automation constitutes one of the most important development trends, and its impact on operational flexibility and error reduction has been widely discussed in the available literature (Ilandarage, 2025). For example, the implementation of real-time location systems significantly improves workplace safety and the efficiency of internal material flows (Halawa et al., 2020). The dynamic development and adoption of mobile robotics, particularly automated guided vehicles and autonomous mobile robots, also impact the transformation

of intralogistics processes in organizations (Piñeiro González, 2025). Kostrzewski et al. (2021) emphasized a significant increase in the technological equipment of Polish logistics centres, while also pointing to strong regional disparities.
The forecasts concerning "warehouses of the future" show that these facilities will be characterized by a high level of automation, interoperability, and the ability to autonomously support operational decision-making (Rodríguez García & Agmoni, 2024). Similar conclusions were drawn in reports, highlighting, i.e. the growing importance of predictive analytics, Internet of Things (IoT) integration, and adaptive resource management algorithms (CEIT Asseco, 2025; LaceUp Solutions, 2025; Wallner, 2025). In turn, Minashkina (2024) indicated that enterprises are seeking for solutions that minimize the negative impact of logistics processes on the environmental, i.e., through automation, optimization of material flow routes, waste reduction, and responsible energy use.

Against the backdrop of an ongoing digital transformation, AI's transformative potential for increasing the efficiency, accuracy, and overall effectiveness of warehouse operations is empathized (Sied, 2024). AI may be implemented to support different operations performance in warehouses (Dewy et al., 2025). Genetic algorithms were utilized to minimize travel time during order picking by generating efficient routes (Obeidat & Puiul, 2024). Recommendations for organizations seeking to leverage AI technologies in warehouse management, highlighting the importance of defining clear objectives, investing in AI talent and training, and embracing collaborative robotics were developed by Tsou (2024).

Selected benefits and concerns related to AI implementation in WMS are presented in Table 2.

The West Pomeranian Voivodeship of Poland plays a growing role in warehouse and logistics processes due to its strategic location in northwestern Poland, close to both the German border and the Baltic Sea. This positioning makes the region a natural hub for international trade, especially for goods moving between Scandinavia, Western Europe, and Central-Eastern Europe. As a result, warehouse operations in this area are increasingly focused on handling cross-border flows efficiently and reliably.

Based on the conducted literature review, it can be stated that although enterprises recognize the strategic importance of WMS, they may face different challenges related to these systems implementation and further development, especially considering implementation of AI in WMS. At the same time, there is a clear research gap concerning perception of WMS adoption and further development in enterprises located in specific regions, such as the West Pomeranian Voivodeship of Poland.

Table 2: Selected benefits and concerns related to AI implementation in WMS (own elaboration based on Shanmugamani & Mohamad, 2023; Berkers et al., 2021; Ilandarage, 2025)

Benefits	Concerns
• Reducing human errors • Reduced duration of operations • Reduction of operational costs • Increased operational accuracy • Automation of routine processes • Improved demand forecasting • Reducing the negative impact of logistics processes on the environment	• Risk of job losses • Ethical concerns • High investment costs • Lack of technology acceptance by employees • Insufficient staff expertise in AI operations • Risk of systemic errors

Methodology

The article aims to examine the benefits and barriers for the development of WMS in enterprises operating in the West Pomeranian Voivodeship of Poland, as well as identify potential areas, benefits and concerns of AI implementation in WMS, considering practitioners viewpoint. The following research questions were formulated:

1. What benefits are achieved through the development of WMS in enterprises?
2. What barriers hinder the development and wider adoption of WMS in enterprises?
3. What are the potential areas of AI implementation in WMS in opinion of companies' representatives?
4. What are the potential benefits of AI implementation in WMS?
5. What are the potential concerns related to AI implementation in warehouses management?

The questionnaire survey was used to conduct the research. Based on the results of comprehensive review of the available literature on WMS application, artificial intelligence utilization in logistics and own observations the questionnaire was developed. The structure and content of the questions were designed to reflect key dimensions identified in prior studies, as well as to address considerations under analysis. Particular attention was paid to ensuring clarity and logical consistency of the questions, as well as their alignment with the research objectives. The developed questionnaire included both closed-ended and open-ended questions, which enabled respondents not only to assess predefined options but also to share their own opinions and experiences. There were also questions, where interviewees had to rate options in five-point scale. This approach increased the content validity of the research instrument and allowed for capturing both measurable evaluations and individual perspectives of respondents. The questionnaire consisted of 15 questions divided into three main thematic sections:

1. Identification of respondent's profile – there were questions concerning respondent, such as gender, age, position held, work experience, type of enterprise, and company size. The analysis of the responses to these questions made it possible to evaluate the diversity of the research sample.
2. Exploring of current use of WMS by respondent – there were questions addressing the scope of WMS applications in companies, their functionalities, perceived benefits, barriers, and plans for further development. The analysis of responses to these questions made it possible to identify the actual level of adoption and use of WMS by surveyed respondents.
3. Exploring of possibilities to implement AI in WMS – there were questions assessing the potential areas of AI technologies application in warehouse tasks execution, expected benefits, perceived concerns. The analysis of responses to these questions allowed for an examination of practitioners viewpoint on enterprises' readiness for next-generation digital transformation.

The questionnaire survey was prepared using the Google Forms platform. The survey targeted employees of supply, manufacturing, and distribution companies operating in the West Pomeranian Voivodeship of Poland. Respondents were selected from among employees involved in warehouse and logistics processes, as they possess practical knowledge relevant to the research topic. Only practitioners from the West Pomeranian Voivodeship in Poland with experience related to WMS unitization were included in the study. The questionnaire was distributed using professional contacts and networks within the region, as well as was available on Facebook, which facilitated representatives of companies operating within supply chains to access it and fill in, as well as share with other practitioners. Participation in the survey was voluntary and anonymous, the collected data were used exclusively for scientific purposes.

The pilot study was carried out. Empirical data were collected between August 2025 and January 2026. A total of 60 respondents representing various positions in enterprises operating in supply chains took part in the study. The collected responses were reviewed considering their completeness. Then obtained data were analysed in detail, providing a basis for the formulation of conclusions.

Results

Within the first section of the questionnaire, respondents were asked to indicate their gender and age group. The data presented in Figure 1 indicate that the largest group of respondents was aged 25–40, with a predominance of males (24 men compared to 9 women). In the 41–55 age group, men also constituted the majority of respondents (12 compared to 3 women). Among the youngest participants aged 18–24, females were more numerous (7 responses versus 4 from males), whereas only one respondent was recorded in the over-55 age group. The age structure of the survey participants shows a clear dominance of respondents aged 25–40, representing the main working-age group. This group is mainly composed of men, which corresponds to the typical workforce structure in the logistics sector.

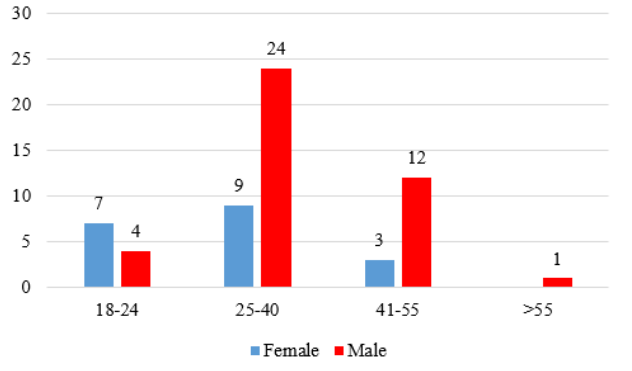

Fig. 1. Age range and gender of respondents, number of responses (own elaboration)

The questionnaire was completed by representatives from different types of enterprises operating within the supply chains. The largest number of responses was obtained from representatives of distribution companies (37 respondents). A smaller share of responses was provided by representatives of manufacturing enterprises (18 responses), while the "Other" option was selected by 5 respondents (Figure 2). The dominance of distribution-focused companies highlights the important role of distribution activities in the West Pomeranian Voivodeship of Poland.

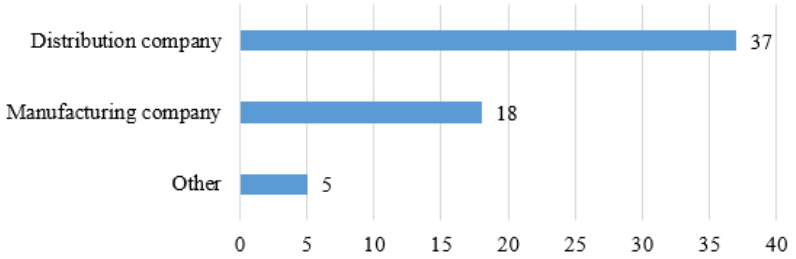

Fig. 2. The type of the enterprise, number of responses (own elaboration)

The number of employees in companies represented by the respondents is shown in Figure 3. The largest group of respondents represented enterprises employing more than 250 employees (38 responses). Among the respondents, 13 were employed in companies with 51–250 employees, 6 worked in firms with 11–50 employees, while 3 represented the smallest enterprises employing fewer than 11 employees. It should be noted that the research sample is clearly dominated by representatives of large enterprises, which may affect propensity to adopt advanced digital technologies, including WMS.

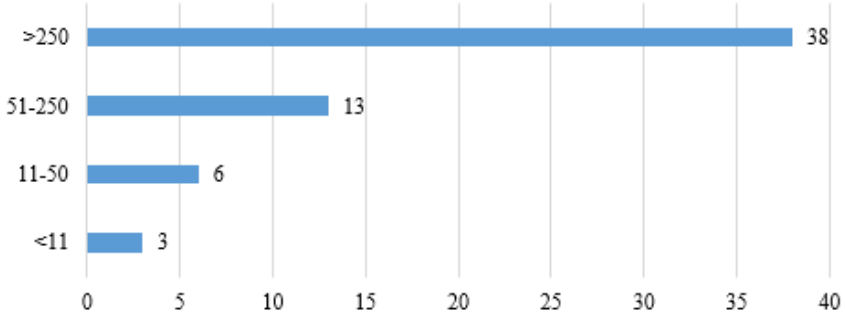

Fig. 3. Number of employees in companies represented by respondents, number of responses (own elaboration)

Figure 4 illustrates the distribution of employment positions held by the surveyed practitioners. The largest group of respondents selected the "Other" option, specifying their roles such as team leaders, technical department employees, quality control staff, maintenance workers, customer service personnel, packers, forklift operators, and specialists performing various support functions (16 responses in total). The next groups included employees

of procurement/distribution departments (14 responses), warehouse workers (11 responses), and department managers (10 responses). Smaller groups of respondents included logistics operators (6 responses) and respondents holding director or president roles (3 responses). It should be mentioned that the respondents' employment structure reflects a high diversity of roles involved in warehouse process, predominated by operational positions and those classified as "Other", as well as complexity of organizational structures in the logistics enterprises.

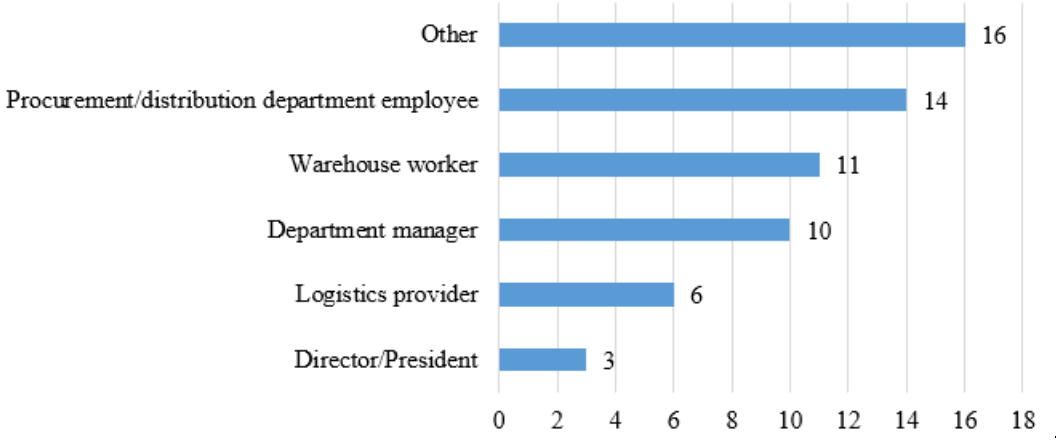

Fig. 4. Employment positions of respondents in enterprises, number of responses (own elaboration)

The distribution of respondents' work experience in a given position is presented in Figure 5. The largest group consisted of respondents with less than 5 years of work experience (32 responses; 53.3%). This was followed by practitioners with 5–9 years of experience (20 responses; 33.3%) and 10–15 years of experience (6 responses; 10.0%). Only a small share of respondents reported having more than 15 years of professional experience (2 responses; 3.3%).

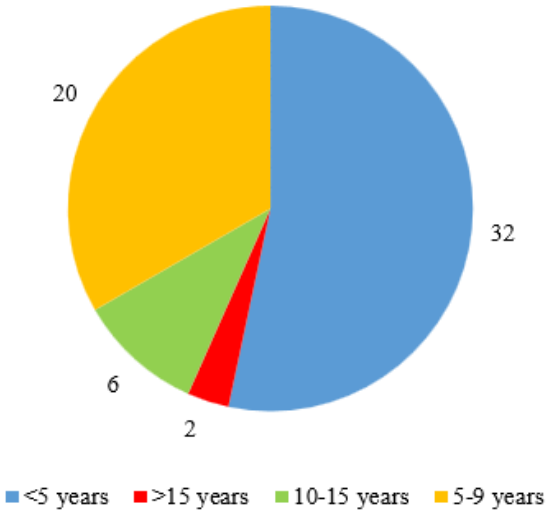

Fig. 5. Respondent's work experience in a given position, number of responses (own elaboration)

Within the second section of the questionnaire, respondents were asked to express their opinions on the current use of WMS in the company (Figure 6). The majority of respondents use WMS that are the part of ERP systems (31 responses). A substantial group of surveyed participants use WMS as a separate software (21 responses). A small number of respondents reported the difficulty in providing an unambiguous answer on WMS configuration (4 respondents) or stated that WMS was not currently used in their position within the companies where they were employed (4 respondents). Based on responses analysis, a dominant role of WMS implementations integrated with ERP systems should be noted, suggesting a tendency toward building a comprehensive information systems in enterprises supporting operations within the entire company. The fact that some respondents were unable to clearly identify the type or configuration of WMS used in their companies may be related to their short work experience and limited level of awareness of systems structure among operational staff. In large organizations, IT

systems are often centrally administered, and employees use only specific functionalities without a thorough understanding of the system architecture.

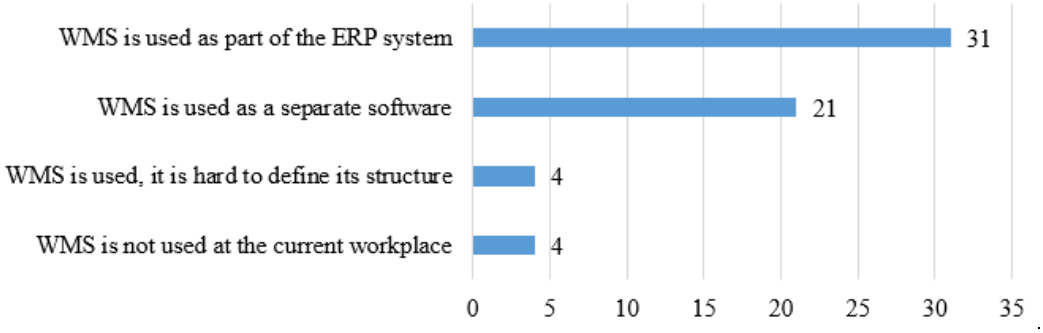

Fig. 6. Current use of WMS in enterprises represented by respondents, number of responses (own elaboration)

Respondents were asked to specify the scope of tasks supported by WMS in their work (Figure 7). It was a multiple-choice question. Only practitioners who currently work with a WMS in their workplace responded to this question. The most frequently indicated tasks included preparation of reports, management of goods location and their flows in warehouses, as well as receiving and dispatching of goods in warehouses (34 responses each). The important tasks were also dealing with forecasting and monitoring inventory levels (33 responses) and conducting the inventory (30 responses). Less frequently indicated were tasks related to management of packaging and logistics units, and managing complaints and returns. Based on the analysis of the collected results, it can be stated that company representatives use WMS functionalities to support operations essential for efficient warehouse processes. Moreover, WMS acts as a coordination tool, facilitating continuous supervision of processes and prompt responses to material flow variations. This result may be impacted by the specific work positions performed by respondents in warehouses.

Fig. 7. Tasks supported by the WMS in the respondents' workplace, number of responses (own elaboration)

Figure 8 presents the benefits that enterprises can achieve through the development of WMS. Practitioners were able to choose multiple options from a predefined list of benefits. The most frequently indicated benefits by respondents were the reduction of human error and process automation (48 responses each). A high number of respondents also pointed to a decrease in order processing times (45 responses). According to the surveyed practitioners, other important benefits also included increased operational flexibility (35 responses) and reduction of warehousing costs (34 responses). Based on collected responses analysis it was revealed that enterprises'

representatives primarily perceive WMS as tools that significantly enhance the operational efficiency of enterprises operating within supply chains. Analysing the most frequently indicated benefits, it can be stated that these systems play a key role in streamlining basic warehouse activities and improving their repeatability, delivering tangible operational, cost-related, and organizational benefits.

Fig. 8. Benefits achieved through the development of WMS, number of responses (own elaboration)

Practitioners also indicated the barriers hindering WMS development in enterprises (Figure 9). It was a multiple-choice question. The high costs associated with purchase and implementation of system were perceived by respondents as the most significant barrier (39 responses). Other key barriers included system complexity and challenges related to its integration with existing IT systems (27 responses), as well as insufficient awareness of system capabilities among warehouse management staff (23 responses). Respondents also pointed to a shortage of qualified personnel (21 responses) and organizational challenges resulting from the need to adapt warehouse infrastructure (20 responses). Based on the analysis of the collected responses, it can be highlighted that WMS development requires a parallel approach that combines financial investment, strengthening employee competences, and preparing organizations for technological change. This may indicate that WMS implementation is perceived not only as a technological project but also as a process requiring organizational transformation. The prominence of financial and technological barriers suggests that despite the recognized benefits of WMS, many enterprises still perceive their development as a resource-intensive undertaking. This is particularly relevant in the case of system integration, which often requires alignment with existing IT infrastructure and business processes. Additionally, the relatively high indication of insufficient awareness of system capabilities among staff may show insufficient knowledge of the system and difficulties in fully utilizing existing WMS functionalities.

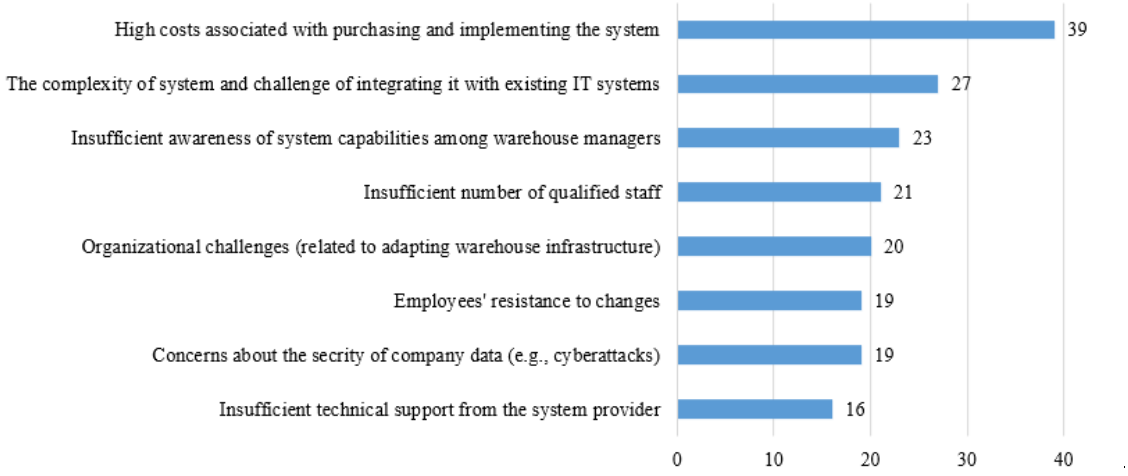

Fig. 9. Barriers hindering the WMS development in enterprises, number of responses (own elaboration)

Figure 10 presents respondents' answers on the question related to plans for the implementation or modernization of WMS over the next five years. Analysis of the collected responses showed that most of respondents (25 individuals) were unable to provide a definite answer to this question. Further 22 respondents declared that the enterprises they represent are considering investment in WMS, while 13 respondents reported that no WMS-related changes are planned in their organizations. The results indicate a high level of uncertainty among enterprises representatives regarding issue analysed; however, a significant proportion of respondents report considering WMS-related investments, which may reflect a growing awareness of the need to improve and digitalize warehouse processes.

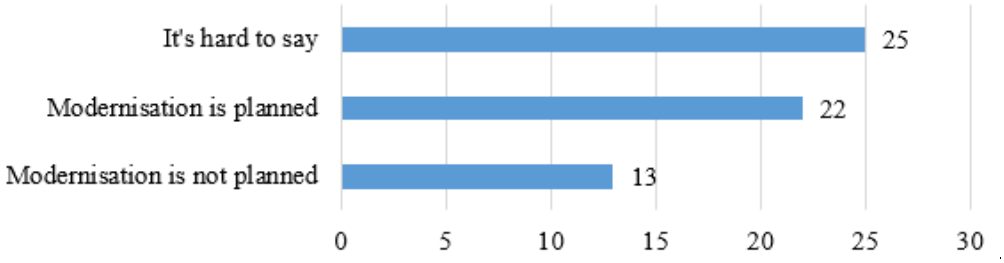

Fig. 10. Plans to implement or modernize WMS by enterprises in the next five years, number of responses (own elaboration)

Within the third section of the questionnaire, respondents were asked to assess the areas of potential application of artificial intelligence in WMS (Figure 11). The assessment was conducted using a five-point scale, where 1 indicated the lowest potential for AI implementation in the selected area, and 5 – the highest potential. The highest ratings were assigned to the use of AI in forecasting stock levels and supply volumes (mean value – 4.42), as well as in the preparation of documentation and reports (4.40). High scores were also given by respondents to stock levels monitoring (4.18) and communication with customers, including the use of chatbots (3.95). Lower ratings were assigned to operational tasks performed directly within the warehouse area, such as goods receiving and dispatching to/from the warehouse (2.77) and orders picking and packing (2.52). The obtained results show that, according to respondents, the greatest potential for AI application in WMS is perceived in analytical and information-oriented tasks. The lower ratings given to operational tasks performed in warehouses may suggest that respondents view the use of AI in these areas as less apparent or more challenging than in analytical and information-based activities. This result may be impacted by several factors:

- operational activities often require manual interaction with goods and infrastructure, which limits the direct use of AI without simultaneous investment in automation technologies (e.g. robotics);
- respondents may associate AI primarily with data analysis rather than execution of physical processes;
- concerns regarding the reliability of AI in real-time operational environments may also have contributed to the obtained assessments, especially considering situations when errors could directly affect customer satisfaction and order fulfilment.

Fig. 11. Areas of potential implementing AI in WMS, arithmetic mean of ratings (own elaboration)

Practitioners also rated the benefits resulting from the application of AI in WMS (Figure 12). Similarly to the previous question, respondents were asked to evaluate the proposed benefits using a five-point scale, where 1 indicated the less significant benefit, while 5 – the most significant benefit. The highest mean values were attributed to the automation of routine processes (mean value – 4.45), improved demand forecasting (4.12), and increased operational accuracy (4.07). Lower, though still notable, scores were recorded for the reduction of operational costs (3.77) and the reducing negative impact of logistics processes on the environment (3.27). The obtained results indicated that artificial intelligence in WMS is primarily perceived as a tool for enhancing the efficiency and accuracy of warehouse processes. Lower ratings given by practitioners for reducing negative impact of logistics processes on the environment show that they do not prioritize this benefit.

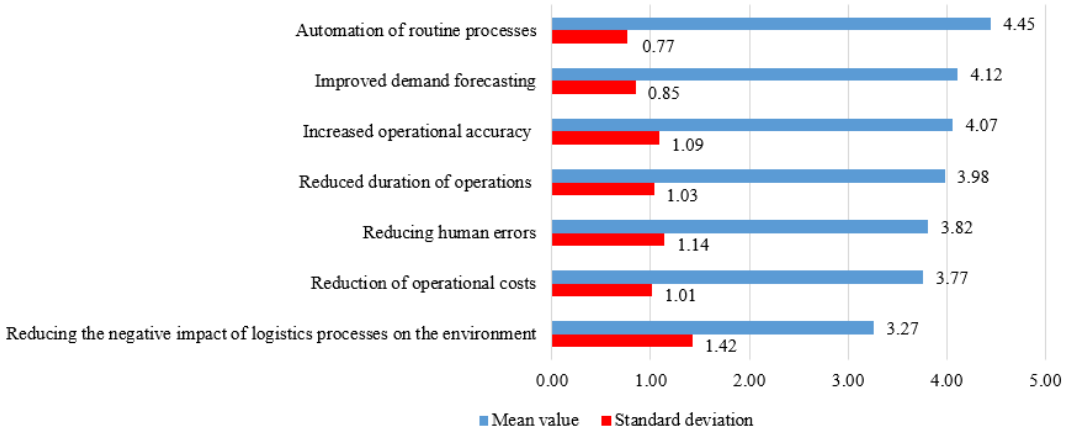

Fig. 12. Potential benefits of implementing AI in WMS, arithmetic mean of ratings (own elaboration)

Figure 13 presents assessments of concerns related to the implementation of AI in warehouses management given by practitioners. Respondents were asked to evaluate the proposed concerns using a five-point scale, where 1 indicated the less significant concern, while 5 – the most significant. The highest mean values were attributed to high investment costs (mean value – 3.82) and the risk of job losses (3.43). Lower ratings were assigned to the risk of system errors (3.15) and ethical concerns (2.78). These results suggest that in respondents' opinion potential concerns are mainly related to implementation costs and the potential impact of AI on employment. Moreover, lower ratings for ethical issues and system-related risks indicate that, in the respondents' opinion, financial and organizational challenges are considered more significant than normative considerations.

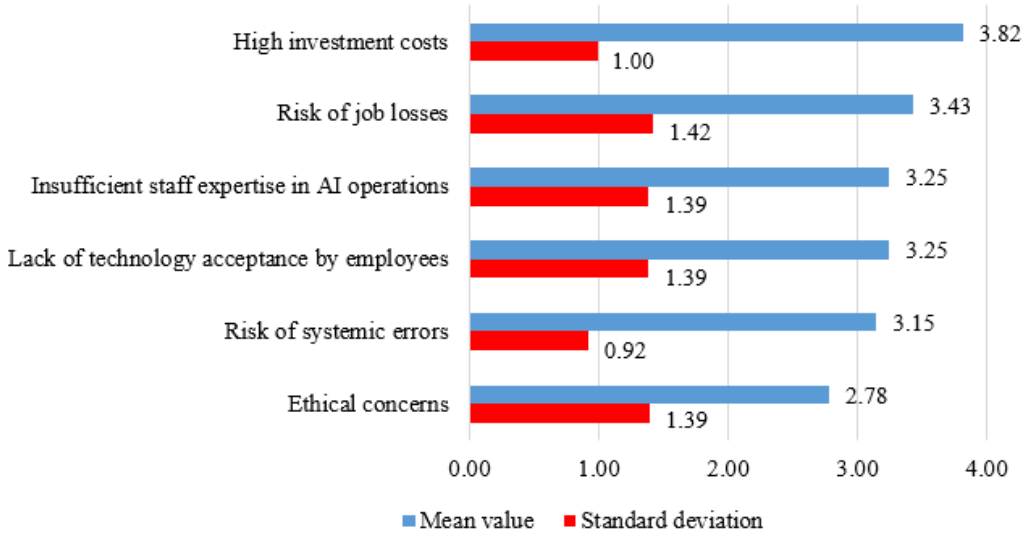

Fig. 13. Potential concerns related to the implementation of AI in warehouses management, arithmetic mean of ratings (own elaboration)

The final question in the questionnaire was open-ended, respondents could express their opinions on the potential implementation of AI technologies in warehouse operations, encompassing perceived benefits, concerns, and future development prospects. The collected statements indicated that the majority of respondents perceive AI as a tool with significant potential for improving warehouse processes. Among its advantages, the following were highlighted: automation of routine activities, reduction of human errors, shorter operations completion times, and increased precision and smoothness of material flows. The respondents also referred to AI implementation-related barriers, pointing to high investment costs, the need for infrastructure modernization, and the necessity of employee training. Some statements additionally emphasized potential workforce resistance, particularly among more experienced employees, as well as concerns related to possible job reductions or the risk of excessive dependence of operational processes on technology. In terms of future development prospects, respondents expressed the prevailing view that AI technologies will be increasingly adopted in warehouse operations, especially in areas related to data analytics, quality control, shipment tracking, and integration with robotics solutions. At the same time, some respondents emphasized that despite ongoing technological progress, the human factor will remain an important element of warehouse operations.

Conclusions

Based on the results of conducted research, it could be concluded that WMS play a significant role in the operations of logistics enterprises located in the West Pomeranian Voivodeship of Poland. WMS primarily support key operational and control tasks, such as reporting, location management, goods flow management, stocktaking and inventory monitoring. The enterprises' employees indicated both caution and a growing readiness for changes in WMS in companies they represent. The share of companies are planning systems implementation or upgrade within the next five years, although part of organizations remain in a 'wait and see' phase.

It was possible to achieve the aim of the study and receive the answers to the set research questions. According to opinions of the surveyed practitioners:

1. The most significant benefits achieved through the development of WMS in enterprises include the reduction of human error, process automation, decrease in order processing times. This shows the current motivation to apply WMS, including needs to achieve better efficiency and transparency in warehouse processes.
2. The most significant barriers hindering WMS development in enterprises are related to finance (high costs of purchase and implementation), technology (the complexity of integration with existing IT infrastructure), and skills (insufficient awareness of WMS capabilities among warehouse management staff). Overcoming these obstacles requires well-structured investment plans, employee training programs, and strong organizational support.
3. The most promising areas for AI implementation in WMS are dealing with analytical and decision-support tasks (stock levels forecasting, reporting, and inventory optimization). This also may indicate that AI is primarily associated with enhancing data processing and insight generation rather than execution of manual

operations in warehouses. Practitioners expect AI to significantly improve planning accuracy, inventory availability, and alignment between demand and supply.

4. The most expected benefits of AI implementation in WMS contain automation of routine processes, improved demand forecasting and increased operational accuracy. The emphasis on automation indicates that AI is expected to reduce manual effort, streamline repetitive warehouse tasks, and improve overall process efficiency. This also suggests that AI can significantly enhance planning accuracy and more responsive supply chain decisions, as well as AI is expected to minimize human errors in warehouse operations, leading to higher reliability of data, processes, and order fulfilment.
5. The most important concerns related to AI implementation in warehouses management are associated with high investment costs and risk of job losses. The emphasis on high investment costs indicates that initial expenditures for adoption AI technologies, infrastructure, and systems integration are crucial, especially for smaller organizations. It also suggests that AI is associated with workforce displacement risks, highlighting fears of automation replacing human labour in warehouse operations.

Based on the conducted analysis, it appears that the conditions for the development of WMS in the West Pomeranian Voivodeship of Poland are relatively favourable, although unevenly distributed. Organizations that invest simultaneously in both technology and employees' competencies have the greatest opportunity to fully leverage the potential of WMS and AI tools, moving toward more flexible, predictable, and disruption-resilient warehouse operations. However, successful implementation of AI in WMS depends largely on people-oriented actions, including fostering acceptance, developing employee capabilities, and redefining roles within operational processes.

It should be noted that the study has a number limitations that should be taken into account when interpreting the results. The research sample was dominated by representatives of large enterprises (employing more than 250 employees), which may have influenced the findings, particularly in terms of technological advancement of these companies, access to resources, and readiness to adopt WMS and AI solutions. As a result, the perspectives of small and medium-sized enterprises (SMEs) may not be considered sufficiently. Moreover, the structure of respondents was mostly composed by individuals performing operational roles in companies, which may have shaped the results toward practical, experience-based evaluations, while limiting the strategic or managerial perspective on WMS development and AI implementation. Furthermore, the pilot study was carried out that focused exclusively on enterprises located in the West Pomeranian Voivodeship of Poland. Consequently, these findings have limited generalisability, considering i.e. that other regions or countries may have different levels of digital maturity and logistics infrastructure. In future studies, the authors intend to continue investigating WMS and AI adoption in warehouse management, with greater emphasis on differences related to enterprise size, respondents' responsibilities, and broader regional coverage.

Research results may provide practical insights for companies, and regional development institutions by showing benefits and barriers to the development of WMS in enterprises, as well as potential areas of AI adoption in WMS. Presented findings may support decision-making processes of software vendors and managerial staff of logistics companies.

Acknowlegements

The research was co-financed by the Interreg SouthBaltic programme within the AIKnowIT project No STHB.01.01-IP.01-0003/24. This project is co-funded by the Polish Ministry of Science and Higher Education under the programme entitled „Co-funded International Projects“ Nr W89/SBP 2021-2027/2025.

References

- Andiyappillai, N. (2023), 'Facets in Warehouse Management Systems (WMS) Implementations in Logistics and Supply Chain,' *International Journal of Computer Applications*, 184(53), 1-6. https://doi.org/10.5120/ijca2023922607.

- Atieh, A.M., Kaylani, H., Al-abdallat, Y., Qaderi, A., Ghoul, L., Jaradat, L., and Hdairis, I. (2016), 'Performance Improvement of Inventory Management System Processes by an Automated Warehouse Management System,' *Procedia CIRP*, 41, 568-572. https://doi.org/10.1016/j.procir.2015.12.122.

- Berkers, F., Rispens, S., and Le Blanc, L. (2021), 'Optimization of Warehouse Management Systems: Implementation and Impact on Operational Efficiency,' *Journal of Scientific Advances in Engineering*

Research, 8(7), 299-304. Available at: https://jsaer.com/download/vol-8-iss-7-2021/JSAER2021-8-7-299-304.pdf (Accessed: 15 October 2025).

- Dabic-Miletic, S. (2024), 'The challenges of integrating AI and robotics in sustainable WMS to improve supply chain economic resilience,' *Journal of Industrial Intelligence*, 2(2), 119-131. https://doi.org/10.56578/jii020205.

- CEIT Asseco (2025), '*The Intralogistics Shift in Poland: AGVs and Automation Reshape Warehousing in 2025'* [Online]. Available: https://www.asseco-ceit.com/en/the-intralogistics-shift-in-poland-agvs-and-automation-reshape-warehousing-in-2025/ (Accessed: 15 October 2025).

- Dewy, C. K., Prambudiab, Y., and Kumalasarib, I. (2025), 'Design of Inventory Information System Model on Smart Warehouse Management System (WMS) Based on Artificial Intelligence (AI) with Integration of Waterfall Method and Design Thinking to Optimize Inventory Accuracy'. *Eduvest - Journal of Universal Studies*, *5*(10), 11898-11911. https://doi.org/10.59188/eduvest.v5i10.51297.

- Dyczkowska, J. A., Olkiewicz, M., and Królikowski, T. (2025), 'The use of artificial intelligence in logistics information systems,' *Procedia Computer Science*, 270, 5198-5206. https://doi.org/10.1016/j.procs.2025.09.647.

- European Business Review (2024), *The Evolving Landscape of Warehouse Management Systems in Europe*. [Online] Available: https://www.europeanbusinessreview.com/the-evolving-landscape-of-warehouse-management-systems-in-europe/ (Accessed: 15 October 2025).

- Fechner, I. (2009), 'Determinants of warehouse space market development in Poland,' *LogForum*, 5(1), 1-10. Available at: https://www.logforum.net/pdf/5_1_3_09.pdf.

- Filina-Dawidowicz, L., Ciesielczyk, D., and Gapski, K. (2025a), 'The use of IT Systems in Road Freight Transport Companies: a case study of the Greater Poland Voivodeship in Poland,' *Proceedings of the 46th International Business Information Management Association (IBIMA) Conference*, Ronda, Spain, 19-20 November, 1034-1048.

- Filina-Dawidowicz, L., Cybulska, D., Ciesielczyk, D., and Gapski, K. (2025b), 'Problems Occurring During the Storage of Goods in Warehouses: A Case Study of the Greater Poland Voivodeship in Poland,' *Proceedings of the 45th International Business Information Management Association (IBIMA) Conference*, Cordoba, Spain, 25-26 June, 1786-1800.

- Filina-Dawidowicz, L., Trojanowski, P., Mrowiński, P., and Troynina, A. (2024), 'Directions of IT Systems Development in Warehouses Management: Polish Practitioners Viewpoint,' in Ivanov, V., Trojanowska, J., Pavlenko, I., Rauch, E. and Piteľ, J. (eds.) *Advances in Design, Simulation and Manufacturing VII. DSMIE 2024*. Cham: Springer, 89-99. https://doi.org/10.1007/978-3-031-61797-3_8.

- Halawa, F., Dauod, H., Lee, I.G., Li, Y., Yoon, S.W., and Chung, S.H. (2020), 'Introduction of a real time location system to enhance the warehouse safety and operational efficiency,' *International Journal of Production Economics*, 224, 107541. https://doi.org/10.1016/j.ijpe.2019.107541.

- Ilandarage, V. (2025), *Digital Transformation in Warehouse Management: The Impact of Automation on Operational Flexibility*. University of Vaasa Working Papers, 19853, 1-22. Available at: https://osuva.uwasa.fi/handle/10024/19853.

- Jomaa, D., Monteiro, T., and Besombes, B. (2013), 'Design and Development of a Forecasting Module: Case of a Warehouse Management System,' *IFAC Proceedings Volumes*, 46(24), 177-182. https://doi.org/10.3182/20130911-3-BR-3021.00013.

- Kalinowski, M., Hering, M., Brejtfus, A., Bernal, T., Fenska-Rompa, A., and Weichbroth, P. (2024), 'Pinquark Warehouse Management System (WMS): Moving from Process-Based to Activity-Oriented Management,' *Procedia Computer Science*. https://doi.org/10.1016/j.procs.2024.09.339.

- Kellermayr-Scheucher, M., Niedermeier, M., and Brandtner, P. (2023), 'Applications and Perceptions of Workforce Management Systems for Warehouse Operation – Results and Findings from Expert Interviews,' *Procedia Computer Science*, 219, 255-262. https://doi.org/10.1016/j.procs.2023.01.288.

- Kłodawski, M., Lewczuk, K., Jacyna-Gołda, I., and Żak, J. (2017), 'Decision making strategies for warehouse operations,' *Archives of Transport*, 41(1), 53-67. https://doi.org/10.5604/01.3001.0009.7384.

- Kostrzewski, M., Filina-Dawidowicz, L., and Walusiak, S. (2021), 'Modern technologies development in logistics centers: the case study of Poland,' *Transportation Research Procedia*, 55, 268-275. https://doi.org/10.1016/j.trpro.2021.06.031.

- Kramarz, M. (2023), 'Barriers to Innovation in Warehouse Management – Case Study,' *Scientific Papers of Silesian University of Technology, Organization and Management Series*, (180), 45-56. https://doi.org/10.29119/1641-3466.2023.180.12.

- LaceUp Solutions (2025), *10 New 2025 WMS Trends (Warehouse Management Systems)*. [Online] Available at: https://www.laceupsolutions.com/10-new-2025-wms-trends-warehouse-management-systems/ (Accessed: 15 October 2025).

- Minashkina, D. (2024), 'A review and research agenda for recent socially and environmentally sustainable practices for warehouse management systems,' *The International Journal of Logistics Management*, 35(2), 215-240. https://doi.org/10.1108/ijlm-07-2023-0265.

- Minashkina, D., and Happonen, A. (2020), 'A development of the warehouse management system selection framework as academic-industrial collaboration work with sustainability considerations,' *AIP Conference Proceedings*, 2233(1), 050012. https://doi.org/10.1063/5.0001884.

- Minashkina, D., and Happonen, A. (2023) 'A systematic literature mapping of current academic research linking warehouse management systems to the third-party logistics context,' *Acta Logistica*, 10(2), 77-89. https://doi.org/10.22306/al.v10i2.377.

- Obeidat, R., and Puiul, M. M. (2024), 'The influence of artificial intelligence on Warehouse Management Systems, '*Proceedings in Manufacturing Systems,* 19(1), 43-50.

- Rodríguez García, M., and Agmoni, E. (2024), *The Warehouse of the Future: Toward Highly Automated, Interconnected, Sustainable Warehouses*. MIT Center for Transportation & Logistics. [Online] Available at: https://ctl.mit.edu/sites/ctl.mit.edu/files/2024-03/The%20Warehouse%20of%20the%20Future.pdf (Accessed: 15 October 2025).

- Shanmugamani, K., and Mohamad, F. (2023), 'The implementation of Warehouse Management System (WMS) to improve warehouse performance in business-to-business (B2B),' *International Journal of Industrial Management*, 17(4), 45-58. https://doi.org/10.15282/ijim.17.4.2023.10091.

- Sied, A. (2024), 'Advancing Warehouse Management Systems: Optimizing Loading-Unloading, Conditioning, Packing and Marking Processes with Adaptive AI Technology', *International Journal of Scientific Research & Engineering Trends*, 10(3), 440-444.

- Wallner, S. (2025), *Explore the 10 Latest Trends in Warehouse Management*. [Online] Available at: https://www.startus-insights.com/innovators-guide/latest-trends-in-warehouse-management/ (Accessed: 15 October 2025).

- Tsou, J.-C. (2024), 'AI-driven automation in warehouse management enhancing efficiency and accuracy,' *International Journal of Information, Business and Management*, 16(4), 138-149.

- Zhang, F., Yang, X., Dang, Y., Wu, C., and Chen, B. (2025), 'Construction and Practice of Intelligent Warehouse Management Decision Support System Based on Artificial Intelligence,' *Procedia Computer Science*, 259, 711-720. https://doi.org/10.1016/j.procs.2025.04.022.