Issues in Information Systems
Volume 27, Issue 4, pp. 375-385, 2026

DOI: https://doi.org/10.48009/4_iis_2026_133

Challenges and dilemmas of artificial intelligence implementation in supply chain management

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Abstract

Artificial intelligence is increasingly transforming supply chain management by supporting demand forecasting, inventory optimization, route planning, warehouse operations, and data-driven decision-making. While previous research has mainly emphasized the benefits and applications of AI in logistics, less attention has been paid to the practical challenges and managerial dilemmas associated with its implementation. The aim of this study is to identify the key challenges and dilemmas related to the implementation of artificial intelligence in modern supply chain management. The study is based on a literature review and quantitative research conducted among 236 logistics managers in Poland using the CAWI method. The findings indicate that the most important implementation challenges include integration with existing IT infrastructure, data security, and cooperation within the partner ecosystem. The main managerial dilemmas concern third-party risk management, workforce-related concerns, cybersecurity risks, and algorithmic bias. The study contributes to the literature by shifting attention from the technological potential of AI to the organizational, managerial, and ethical conditions of its effective use in supply chains. From a practical perspective, the findings may support logistics companies in making more informed decisions about AI adoption, particularly in relation to infrastructure readiness, cybersecurity, partner selection, employee adaptation, and responsible algorithmic decision-making.

Keywords: artificial intelligence; supply chain management; logistics; AI implementation; cybersecurity; data integration; logistics managers; digital transformation

Introduction

Artificial intelligence (AI) is changing many industries, and now has a great deal of influence on the logistics and parcel delivery industries. The complexity and amount of data that this industry needs, along with the demand for much leaner processes than in the past, have led individuals to increasingly consider AI systems. For example, transportation systems are supported with AI technology for route optimization at different levels, from route and rideshare services, to predict the exact day and time that users will receive their packages (Hu et al., 2020). Many new issues have also become of interest because, as AI technology progresses to address new challenges, many paradigms developed during the AI and logistics revolution have required reassessment of conventional solutions. This article examines AI implementation in logistics and supply chain management, with particular attention to current developments, practical challenges, and managerial dilemmas. The term logistics has developed and evolved tremendously in the past few years. It primarily centers on the management and integration of products, services, and information from supplier check points to the consumer's doorstep. Efficient management and optimization of the logistics system throughout the supply chain are the main concerns of this enterprise. The evolution and acceptability of

emerging technologies have transformed existing dynamic systems with their numerous latest applications (Ghiani et al., 2022).

Artificial intelligence is reshaping warehouse operations too by automating decisions that were once manual, intuition-driven and error-prone. Warehouses now account for a significant share of logistics cost, yet they also generate rich data from radio-frequency scanners, sensors and autonomous mobile robots (AMRs) that AI can exploit to cut travel, labour and space waste. Recent empirical studies on AI-assisted order-picking and surveys of AMR deployments agree that data-driven optimization has moved beyond pilots and is becoming a mainstream source of competitive advantage in fulfilment centres (Keith & La, 2024; Rad et al., 2025).

Although previous studies have examined the benefits and applications of AI in logistics and supply chain management, less attention has been paid to the practical challenges and managerial dilemmas associated with AI implementation. This gap is particularly important because logistics companies must not only adopt AI tools, but also manage integration problems, cybersecurity risks, data quality issues, partner dependencies, and workforce-related concerns.

The aim of this article is to identify the key challenges and dilemmas associated with the implementation of artificial intelligence in the management of modern supply chains. The study addresses two key research questions: RQ1: What are the main challenges of implementing AI in modern supply chain management? and RQ2: What dilemmas do managers face when implementing AI in supply chain management? To answer these questions, the article draws on a literature review, expert opinions, and quantitative research conducted among logistics managers. The article is structured as follows: First, the background and literature review present the state of AI applications in supply chains. Next, the methodology section outlines the research design, including sample characteristics and data collection methods. This is followed by a discussion of empirical findings, which highlights specific challenges and dilemmas related to AI implementation in contemporary supply chains. The article concludes with a synthesis of insights and directions for future research, emphasizing the value of using AI in logistics companies.

Background and Literature Review

Artificial Intelligence is reshaping logistics and transport by converting heterogeneous operational data such as orders, telematics, sensor feeds, weather, and infrastructure states into timely, auditable decisions that lift efficiency, resilience, safety, and sustainability. Under intensifying global trade and environmental constraints, organizations depend on AI to align capacity with volatile demand, anticipate bottlenecks, and orchestrate scarce resources without eroding service quality. Well-designed data pipelines, robust features, and human-in-the-loop controls let AI compress decision latency across planning through execution while supporting decarbonization through fewer empty miles, reduced idling, and better asset utilization (Cannas et al., 2024; Culot et al., 2024).

The logistics industry is particularly well suited for the use of AI due to its specific characteristics (Fig. 1). The environment in which logistics systems operate is characterized by a fluctuating consumer market, many different actors, and opposing goals that need to be reconciled. It is therefore a highly dynamic and complex environment, which leads to complex optimization problems that need to be solved to achieve efficient and sustainable logistics processes. Methods in AI have the ability to capture the complex relationships in logistics environments. In order to do so, they require a lot of data. Data becomes more and more widely available in the logistics industry with the widespread use of technology such as sensors, cameras, tracking and tracing systems or digital twins, even though sharing data between companies in the logistics industry can be challenging due to data privacy and sovereignty concerns, security risks, and differences in data formats and systems used by each company. The complex decisions that control logistics processes are often made by experts and thus depend on the experience of employees. The shortage of

skilled workers is a trend that will also become increasingly relevant for the logistics industry in the future, so that AI with the ability to generate and capture knowledge will become a key factor. For example, with a contribution of 5% of the EU's gross domestic product, more than 6 million employees, and 25 % of the EU's total greenhouse gas emissions, the transport industry alone plays a significant role in the European economy and holds major potentials for optimization approaches based on AI methods (European Commission, 2023).

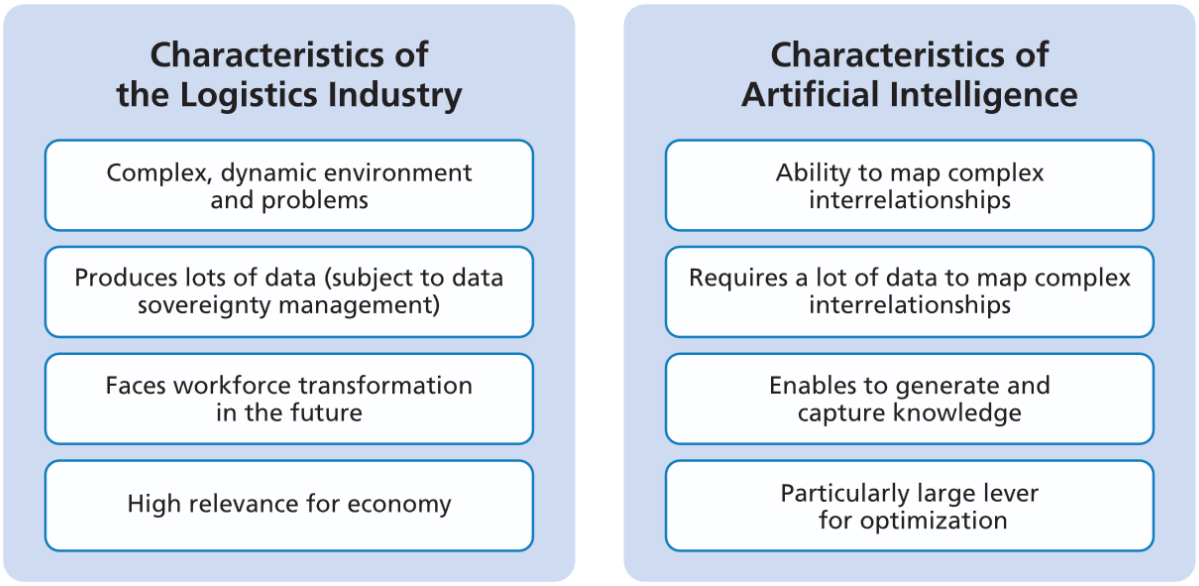


Figure 1. Relevance of AI for the logistics industry
Source: Murrenhoff, et al., (2023)

The scientific literature provides extensive evidence on the use of AI in logistics and supply chain management. Particularly relevant studies include systematic literature reviews, capability-based frameworks, and research roadmaps that examine AI applications, implementation processes, and future research directions in this field. Important contributions include the systematic literature review by Culot et al. (2024), the capability-based framework proposed by Jackson et al. (2024), and the research roadmap developed by Richey et al. (2023). Relevant findings are also presented in studies that directly address supply chain resilience, risk management, and the implementation of AI-based solutions. This area is discussed especially by Belhadi et al. (2024), Chowdhury et al. (2024), and Mohsen (2023). The number of publications related to AI and logistics between 2015 and 2024 is presented in Figure 2. The search was conducted in Web of Science and Scopus using the keywords "artificial intelligence" AND "logistics" OR "supply chain management". The analysis included journal articles and conference papers published between 2015 and 2024. The results from both databases were combined, and duplicate records were removed before the final count.

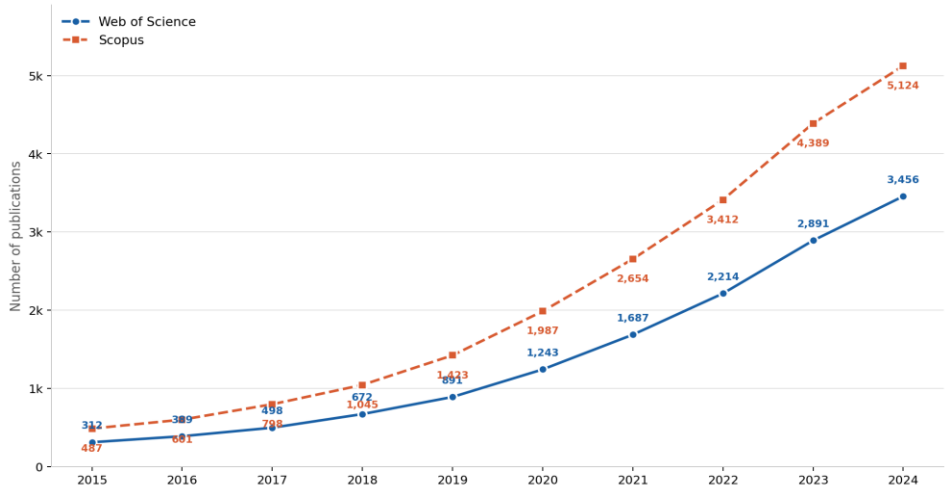


Figure 2. Number of publications related to AI and logistics between 2015 and 2024
Source: own elaboration based on Web of Science and Scopus.

Particularly valuable AI-based solutions relate to demand forecasting and predictive analytics (e.g., Pasupuleti et al., 2024), as well as sustainable and green supply chain management (e.g., Zejjari & Benhayoun, 2024). Although there is an abundance of literature on artificial intelligence in logistics, there is still a noticeable lack of studies on the challenges and dilemmas associated with applying AI solutions in contemporary supply chains. This research gap is important because the future use of AI in the logistics market depends not only on technological capabilities, but also on the ability of organizations to address implementation barriers, managerial concerns, and operational risks.

Methodology and Research Questions

The theoretical background presented the main areas of AI application in supply chain management. The main research objective of this article is to identify and assess the key challenges and dilemmas associated with the implementation of artificial intelligence in the management of modern supply chains. To achieve this objective, the study seeks to answer two key research questions: (1) What are the main challenges of implementing AI in modern supply chain management? and (2) What dilemmas do managers face when implementing AI in supply chain management?

To achieve the research objective and address the identified research gap, namely the lack of detailed analyses concerning the challenges and dilemmas related to the future implementation of AI in supply chains, logistics managers operating in the Polish market were selected as the target group. This choice was justified by the professional experience of the selected managers in implementing AI solutions in logistics. Based on a comprehensive literature review concerning AI implementation in logistics, a quantitative survey in the form of a structured questionnaire was developed. The instrument was organized into three parts. The first part addressed RQ1 and asked respondents to identify, from a closed list of implementation challenges derived from the literature, the single challenge they considered most important in their organization, with an open "other" option allowing them to add a challenge based on their own experience. The second part addressed RQ2 and, in the same single-choice format, asked respondents to indicate the managerial dilemma they regarded as most significant. In both parts, respondents assessed AI-supported solutions, understood as tools based on machine learning, predictive analytics, automation, and decision-

support algorithms. The third part was a confidential section collecting demographic information on gender, age, and company size. A pilot study was conducted with a sample of 28 logistics managers, including 19 representatives of medium-sized enterprises and 9 representatives of large enterprises, to identify and eliminate any ambiguities in the questionnaire and ensure the clarity and comprehensibility of the questions for all respondents.
In the first quarter of 2026, the main survey was conducted among logistics managers using the CAWI method (Computer Assisted Web Interview) – the questionnaire was made available online and distributed via a dedicated link. Participation in the study required respondents to declare that they actively used AI-supported solutions in logistics processes. The study used a purposive sample of 236 logistics managers representing medium-sized and large enterprises. The detailed structure of the research sample is presented in Table 1.

Table 1. Characteristics of the Research Sample

Variable	Category	Number of respondents
Gender	Female	49
Gender	Male	187
Age	Under 35	59
Age	36–45	112
Age	46 and above	65
Company size	Medium-sized enterprises	194
Company size	Large enterprises	42

Source: own.

Descriptive statistics and positional measures were used to analyze the collected data. Because each research question was operationalized through a single-choice item capturing the respondent's most important challenge or dilemma, the analysis focuses on the relative frequency of responses across categories. Exploratory cross-tabulations were also examined to check whether the ranking of the leading challenges and dilemmas differed across company size and age groups; the ordering of the dominant categories remained stable across these subgroups, so the aggregated distributions are reported below. Given the purposive sampling design and the uneven size of the demographic subgroups, these comparisons are treated as exploratory rather than confirmatory. Internal consistency was assessed for the set of perception items measuring respondents' assessments of AI implementation challenges and managerial dilemmas, treated as a single attitudinal scale. The Cronbach's alpha coefficient for these items was 0.79, indicating satisfactory internal consistency. Reliability was not computed for the single-choice and demographic items, for which the coefficient is not applicable.

Findings and Discussion of Findings

The results presented in the article are part of a wide-ranging study and, due to the limitations introduced, are presented only in relation to the essence of the phenomenon studied. The first part of the empirical study

focused on collecting data and information to address the first research question: What are the main challenges of implementing AI in modern supply chain management?
Before presenting the results, it is necessary to distinguish the two categories analyzed in this study. Implementation challenges are understood here as operational and technical obstacles that hinder the deployment of AI in supply chains and that can, in principle, be resolved through investment, technical work, or process change; examples include integration with legacy IT systems or insufficient data quality, where the desired course of action is clear and the difficulty lies in execution. Managerial dilemmas, by contrast, are situations in which managers must choose between competing and partly irreconcilable objectives, so that no option is unambiguously correct and any decision entails accepting a trade-off or residual risk. On this basis, third-party risk management is classified as a dilemma rather than a challenge: although organizations can mitigate supplier-related vulnerabilities, they cannot eliminate their dependence on external AI providers without forgoing the very capabilities those providers supply, which forces a continuing trade-off between operational benefit, security exposure, and loss of control. The same logic applies to the workforce, cybersecurity, and algorithmic-bias dilemmas, each of which requires balancing efficiency gains against organizational, ethical, or accountability concerns.
Based on the literature review and previous managerial experience in logistics processes, respondents were presented with a list of potential challenges related to AI implementation in modern supply chain management. In addition, each respondent had the opportunity to indicate another area that, based on their own professional experience, they considered relevant. Figure 3 presents an aggregated overview of the results obtained in percentage terms.

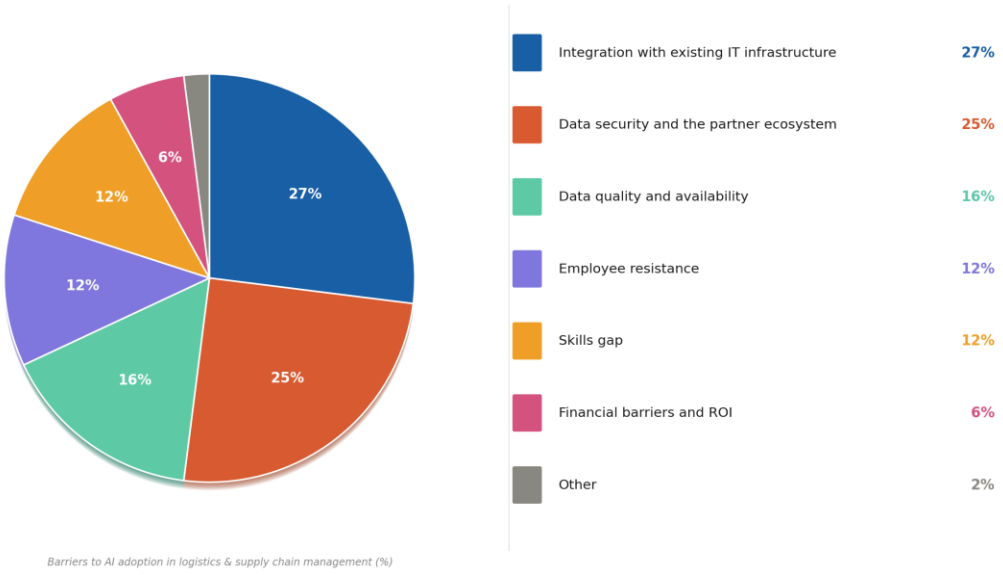


Figure 3. Main Challenges of Implementing AI in Supply Chain Management
Source: own.

Among the responses indicated, the largest number of responses referred to the Integration with existing IT infrastructure (27%). Respondents noted that many companies still rely on outdated systems (so-called legacy systems) that were not designed to work with modern machine learning (ML) models. In addition, it was noted that upgrading infrastructure and systems such as ERP (Enterprise Resource Planning) and WMS (Warehouse Management System) requires time and advanced engineering expertise, and carries a high risk of operational downtime. Many of the indications (25%) also concerned Data security and the partner ecosystem. In this case, the prevailing view was that a greater number of digital touchpoints and

IoT sensors in the supply chain also expands the potential attack surface for cybercriminals. It was also emphasized that the supply chain relies on relationships with numerous external subcontractors and partners. Sharing data in real time requires a high level of trust among network participants, who may be reluctant to disclose internal business data. Respondents considered financial barriers and the return on investment to be the least (6%) significant challenges. Although the initial costs of implementing advanced AI tools are high, as they include the purchase of technology, system integration, and, not infrequently, fees for consulting services and licenses, respondents believe that these costs are worth incurring and that they pay for themselves relatively quickly.

The second part of the empirical study addressed the second research question: What dilemmas do managers face when implementing AI in supply chain management? This part focused on the managerial, organizational, technological, and ethical dilemmas associated with the broader implementation of AI in supply chains. The value of this part of the study lies in identifying managerial dilemmas based on respondents' professional experience in logistics and supply chain management. Figure 4 presents an aggregated overview of the results obtained in percentage terms.

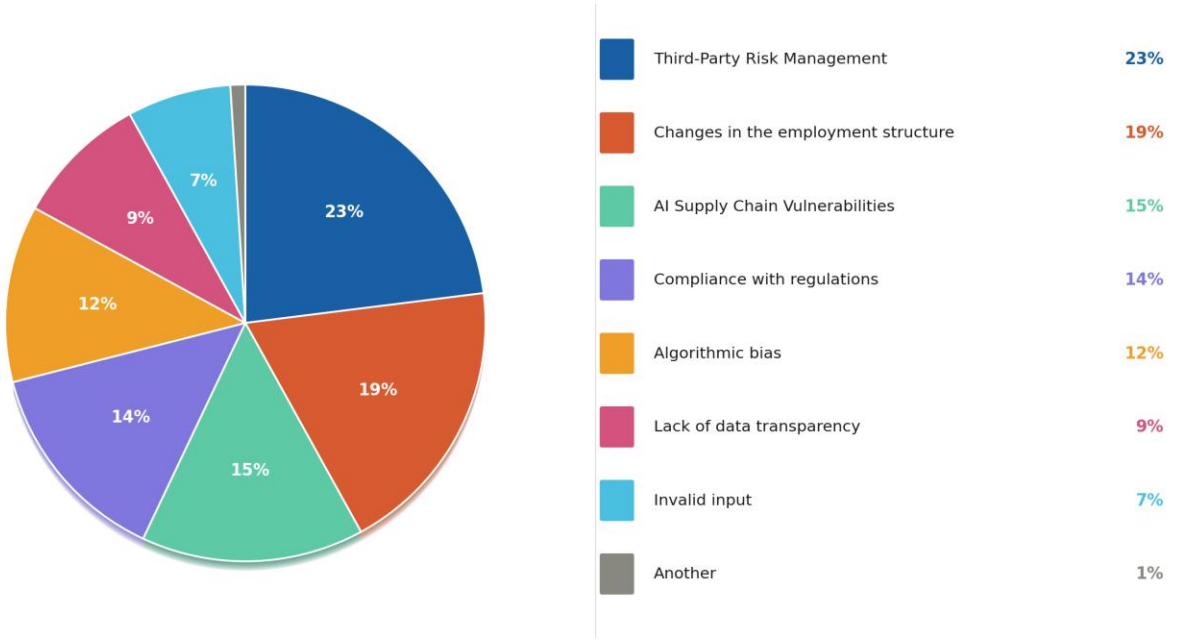


Figure 4. Main Managerial Dilemmas Related to AI Implementation in Supply Chain Management
Source: own.

The results indicate that 23% of respondents identified Third-Party Risk Management as the most important dilemma related to implementing artificial intelligence in modern supply chain management. According to the surveyed managers, many companies still lack full visibility into the AI systems used by suppliers further down the supply chain, which makes it difficult to respond effectively to cyber incidents. It was also noted that logistics systems rely on third-party software providers and autonomous AI agents. Security vulnerabilities in these systems could expose companies to cyberattacks, leaks of sensitive commercial data, or model memory poisoning by competitors or hackers.

The second most frequently cited concern, indicated by 19% of respondents, was related to the automation of repetitive processes, such as route planning, order fulfillment, and warehouse operations, which raises fears of job cuts. Companies must therefore address public concerns and the need for costly employee retraining. Another important issue concerned algorithmic bias, indicated by 12% of respondents.

According to the surveyed managers, algorithms designed to optimize costs or routes may discriminate against certain groups, for example by overlooking smaller suppliers or regions with poorer infrastructure, as a result of errors in the training data.

When the research findings are examined in relation to the second research question, a clear picture emerges of the dilemmas faced by today's logistics managers responsible for implementing artificial intelligence in supply chain management. It is worth noting that a comprehensive approach to the phenomenon under study is essential, as is the development of further courses of action based on multi-criteria analysis.

These findings can be related to the prior studies identified in the literature review. The prominence of integration with existing IT infrastructure and data quality echoes the systematic review by Culot et al. (2024), which reports that organizational and data-related conditions, rather than algorithmic performance alone, determine whether AI deployments succeed, and it is consistent with the capability-based perspective of Jackson et al. (2024), in which absorptive and integration capabilities mediate the value of generative AI. The salience of data security and partner-ecosystem cooperation aligns with the resilience- and risk-oriented research of Belhadi et al. (2024) and Chowdhury et al. (2024), who stress that AI both strengthens and reconfigures supply chain risk exposure. At the same time, the present results extend this body of work: whereas earlier studies foreground the benefits and capabilities of AI, the managerial dilemmas identified here, particularly third-party risk management and algorithmic bias, point to governance and accountability concerns that the roadmap of Richey et al. (2023) flags as underexplored. The study therefore corroborates the technological and organizational themes of prior research while adding an explicitly managerial and ethical dimension to them.

Table 2. Framework of AI Implementation Challenges and Managerial Dilemmas

Category (type)	Survey result	Definition	Managerial implication	Supporting literature
IT infrastructure integration (challenge)	27%	Technical difficulty of connecting AI tools to legacy ERP/WMS systems not designed for machine learning.	Assess system compatibility and plan phased upgrades.	Culot et al. (2024); Jackson et al. (2024)
Data security & partner ecosystem (challenge)	25%	Expanded attack surface from added digital touchpoints and the need for data-sharing trust among partners.	Strengthen cybersecurity and data-governance agreements with partners.	Belhadi et al. (2024); Chowdhury et al. (2024)
Third-party risk management (dilemma)	23%	Trade-off between benefiting from external AI providers and accepting reduced visibility and control over their systems.	Vet providers and define accountability for outsourced AI.	Richey et al. (2023); Chowdhury et al. (2024)
Workforce concerns (dilemma)	19%	Tension between automating repetitive tasks and managing job-loss fears and retraining costs.	Plan reskilling and transparent change management.	Richey et al. (2023)
Algorithmic bias (dilemma)	12%	Risk that cost- or route-optimizing models disadvantage smaller suppliers or under-served regions through biased training data.	Audit models and keep algorithmic decisions explainable.	Richey et al. (2023); Jackson et al. (2024)

To sum up the empirical part of the article, the findings indicate a wide range of challenges and dilemmas associated with implementing artificial intelligence in modern supply chain management. Therefore, the obtained results should be considered a reference point for further, extended scientific research in this important area.

Conclusions

The aim of this article was to identify the key challenges and dilemmas associated with the implementation of artificial intelligence in modern supply chain management. Based on the literature review and empirical research conducted among logistics managers, the study confirms that AI is increasingly perceived as a transformative technology capable of improving forecasting, planning, inventory management, route optimization, warehouse operations, and data-driven decision-making in logistics and supply chains.

In response to the first research question, the study identified integration with existing IT infrastructure, data security, and cooperation within the partner ecosystem as the most important challenges of AI implementation in supply chain management. These findings indicate that the effective use of AI depends not only on access to advanced technologies, but also on the readiness of organizational systems, the quality and integration of data, cybersecurity safeguards, and the ability to cooperate with external partners in a secure and trusted digital environment.

In response to the second research question, the main managerial dilemmas concerned third-party risk management, workforce-related concerns, cybersecurity threats, and algorithmic bias. The results show that managers implementing AI in supply chains must balance technological efficiency with organizational responsibility. On the one hand, AI can improve operational performance and support more accurate decision-making. On the other hand, it creates new risks related to dependence on external technology providers, employee adaptation, data protection, transparency of algorithmic decisions, and accountability for automated processes.

The study contributes to the literature on artificial intelligence in supply chain management by shifting attention from the benefits and applications of AI to the practical, organizational, and ethical conditions of its implementation. It shows that the successful adoption of AI in supply chains requires more than technological investment. It also requires infrastructure readiness, reliable data governance, cybersecurity awareness, employee competence development, and responsible cooperation with technology partners.

From a practical perspective, the findings may support logistics companies in preparing for AI implementation. In particular, managers should assess the compatibility of AI tools with existing IT systems, strengthen cybersecurity procedures, verify the reliability of external providers, prepare employees for changes in work processes, and ensure that algorithmic decisions remain transparent, explainable, and aligned with organizational goals. AI implementation should therefore be treated not as a one-time technological upgrade, but as a strategic process involving technological, managerial, human, and ethical dimensions.

Limitations and Future Research Directions

This study has several limitations that should be considered when interpreting the results. First, the research was conducted among logistics managers operating in the Polish market, which limits the possibility of generalizing the findings to other countries and institutional contexts. Future studies could compare AI implementation challenges across different national markets and examine how regulatory, technological, and cultural factors influence managerial perceptions of AI in supply chains.

Second, the study was based on survey data collected using the CAWI method. Although this approach made it possible to gather responses from a relatively large group of managers, it relied on self-reported

opinions and declarations. Future research could complement quantitative survey results with qualitative interviews or case studies to gain deeper insight into the decision-making processes, organizational tensions, and practical experiences associated with AI implementation.

Third, the study focused on selected challenges and dilemmas identified on the basis of the literature review and managerial experience. Future research could expand the set of analysed factors by including issues such as regulatory compliance, environmental sustainability, AI explainability, employee resistance, organizational culture, data ownership, and long-term return on investment.

Fourth, the research had a cross-sectional character, which means that it captured managerial perceptions at one point in time. As AI technologies develop rapidly, future longitudinal studies would be valuable for examining how implementation challenges and dilemmas change over time, especially after companies gain more experience with AI-supported logistics processes.

Future research should also investigate differences between sectors, company sizes, and levels of digital maturity. Comparative studies between medium-sized and large enterprises could provide a more detailed understanding of how organizational resources influence AI adoption. In addition, further research could explore the relationship between AI implementation, supply chain resilience, trust between supply chain partners, and the ethical governance of algorithmic decision-making. Such studies would help develop a more comprehensive understanding of how artificial intelligence can be implemented responsibly and effectively in modern supply chains.

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