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USE OF ARTIFICIAL INTELLIGENCE AND PREDICTIVE ANALYTICS IN FORECASTING LOGISTICS RISKS: CONTEMPORARY APPROACHES TO SUPPLY CHAIN RESILIENCE MANAGEMENT IN THE UNITED STATES

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Abstract. *The purpose* of the article is to examine contemporary approaches to the application of artificial intelligence (AI) and predictive analytics in logistics risk forecasting, analyze their implementation in supply chain management systems of U.S. enterprises, and develop the author's conceptual framework for integrating AI and predictive analytics into logistics risk management in order to enhance supply chain resilience in the context of the digital transformation of the U.S. economy. *Research methodology.* The methodological framework of the study is based on a combination of general scientific and specialized research methods. Methods of analysis, synthesis, and literature review were employed to systematize contemporary theoretical approaches to the application of AI and predictive analytics in logistics risk forecasting. A systems approach was used to examine the interrelationships among supply chain components and logistics risk management processes. Comparative analysis was applied to investigate AI implementation practices adopted by leading U.S. companies. The method of generalization was used to identify major trends in the digital transformation of logistics and to formulate the study's conclusions. A graphical method was employed to develop the author's conceptual framework for integrating AI and predictive analytics into a logistics risk forecasting system. Finally, the logical-analytical method was applied to substantiate directions for improving supply chain resilience management under conditions of economic digital transformation. *Results.* The findings indicate that the implementation of artificial intelligence and predictive analytics is fundamentally transforming logistics risk management by enabling a shift toward data-driven models based on continuous monitoring and forecasting of potential supply chain disruptions. The study demonstrates that the effectiveness of such systems depends on the integration of heterogeneous data sources, the application of machine learning algorithms, and their interaction with enterprise information platforms. The analysis of best practices adopted by leading U.S. enterprises made it possible to systematize the principal areas of AI application in logistics, including demand forecasting, transportation route optimization, inventory management, supplier reliability assessment, real-time monitoring of logistics operations, and decision support. The study found that the integrated use of these technologies significantly enhances the adaptability of supply chains to external risks. *Practical implications.* A major practical outcome of the research is the development of the proposed conceptual framework for integrating AI and predictive analytics into a logistics risk forecasting system. Unlike existing approaches, the proposed framework combines data collection and processing, intelligent forecasting, risk assessment, decision support, and a continuous model improvement mechanism based on newly generated data. This integrated approach provides a foundation for improving logistics management efficiency and strengthening supply chain resilience. The proposed framework may be applied by enterprises, logistics service providers, and other organizations in developing digital risk management strategies, as well as in future research on intelligent decision support systems for logistics. *Value/Originality.* The principal theoretical contribution of this study is the development of an original conceptual framework for integrating Artificial Intelligence and Predictive Analytics into logistics risk forecasting systems. The framework combines data acquisition, intelligent data analytics, risk forecasting, decision support, and the continuous improvement of predictive models within a unified digital architecture. The proposed approach may serve as

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a methodological foundation for the development of digital logistics management systems across enterprises operating in various industries.

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JEL Classification: C53, D81, L91, M11, O3

1. Introduction

The rapid digitalization of the economy, increasing geopolitical instability, disruptions to global transportation and logistics networks, the aftermath of the COVID-19 pandemic, climate change, and the growing number of cyber threats have significantly increased uncertainty in the functioning of modern supply chains. According to the World Economic Forum, risks associated with geopolitical fragmentation, cybersecurity, and extreme weather events rank among the most significant global challenges facing businesses and international logistics (World Economic Forum, 2025). Under these conditions, supply chain resilience has become one of the strategic priorities for business management (Sheffi, 2024; Ivanov, 2024). One of the most promising approaches to enhancing logistics risk management is the application of artificial intelligence (AI) and predictive analytics. These technologies enable organizations to analyze large volumes of data, forecast potential supply chain disruptions, identify emerging risks at an early stage, and support managerial decision-making in real time (Queiroz & Fosso Wamba, 2023; Büyüközkan & Göçer, 2021; Sanders, 2023; National Institute of Standards and Technology, 2023).

According to studies conducted by Gartner, McKinsey, and Deloitte, the adoption of AI in logistics has become one of the principal drivers of enterprise digital transformation, while predictive analytics is increasingly recognized as a critical tool for enhancing the adaptability and competitiveness of modern supply chains (Gartner, 2024, 2025; McKinsey Global Institute, 2024; Deloitte, 2025). Therefore, investigating the integration of AI and predictive analytics into logistics risk forecasting systems for U.S. enterprises is both scientifically relevant and of considerable practical importance.

Practical aspects of logistics digital transformation, artificial intelligence, and predictive analytics have been extensively addressed in reports published by Gartner (2024, 2025), McKinsey Global Institute (2024), Deloitte (2025), and the World Economic Forum (2025), as well as in publications by IBM (2024), Oracle (2024), Microsoft (2024), Amazon Web Services (2024), UPS (2024), FedEx (2024), Walmart (2025), DHL (2024), and A.P. Moller–Maersk (2024), which illustrate contemporary approaches to implementing AI-driven solutions in global logistics operations. Nevertheless, the application of AI and predictive analytics specifically to logistics risk forecasting in U.S. enterprises requires further scientific investigation. Despite the growing body of research, limited attention has been paid to the comprehensive integration of artificial intelligence, predictive analytics, and decision support systems within logistics risk forecasting and supply chain resilience management. This research gap motivated the selection of the topic and determined the purpose and objectives of the study.

The purpose of the article is to examine contemporary approaches to the application of artificial intelligence (AI) and predictive analytics in logistics risk forecasting, analyze their implementation in supply chain management systems of U.S. enterprises, and develop the author's conceptual framework for integrating AI and predictive analytics into logistics risk management in order to enhance supply chain resilience in the context of the digital transformation of the U.S. economy.

2. Key Theoretical Approaches

The contemporary global economy is characterized by a high degree of uncertainty driven by geopolitical instability, the transformation of international trade, the accelerated digitalization of business processes, climate change, pandemic-related disruptions, and interruptions to global transportation and logistics networks. Under these conditions, supply chain resilience has become a critical determinant of both corporate competitiveness and broader economic stability (Christopher, 2022; Sheffi, 2024; World Economic Forum, 2025). Recent events – including the COVID-19 pandemic, semiconductor shortages, disruptions to international transport corridors,

military conflicts, and the reconfiguration of global production networks – have exposed the vulnerability of even the most advanced logistics systems. These developments underscore the need to transition toward new approaches to logistics risk management based on digital technologies and predictive analytics (Sheffi, 2024; Ivanov, 2024; Wieland & Durach, 2021; Queiroz & Fosso Wamba, 2023; World Economic Forum, 2025).

Traditional logistics risk management methods primarily rely on historical data, statistical models, and expert judgment. However, modern supply chains operate in highly dynamic environments characterized by an ever-increasing number of interconnected risk factors and massive volumes of real-time data that exceed the analytical capabilities of conventional approaches. Consequently, organizations face limitations in their ability to identify emerging threats promptly, forecast potential disruption scenarios, and make timely and effective managerial decisions.

Against this background, the adoption of artificial intelligence (AI) and predictive analytics has emerged as one of the most significant developments in modern logistics. The integration of machine learning algorithms, big data analytics, digital twins, the Internet of Things (IoT), and advanced information platforms enables organizations not only to monitor logistics operations in real time but also to predict risks, estimate their probability, optimize transportation routes, forecast demand, identify unreliable suppliers, and develop alternative supply chain scenarios (Queiroz & Fosso Wamba, 2023; Büyüközkan & Göçer, 2021). Predictive analytics facilitates the transition from reactive to proactive risk management, which constitutes the foundation of resilient and adaptive supply chains (National Institute of Standards and Technology, 2023; Gartner, 2025).

The experience of the United States is of particular interest, as the country is a global leader in the adoption of digital technologies for logistics and supply chain management. Leading U.S. companies, including Amazon, UPS, Walmart, FedEx, IBM, Oracle, and Microsoft, extensively employ AI and predictive analytics to forecast delivery delays, optimize inventory management, assess supplier risks, predict demand, and support strategic logistics decision-making (IBM, 2024; Oracle, 2024; Microsoft, 2024; Amazon Web Services, 2024). The practical experience of these companies demonstrates that integrating AI-based solutions into logistics operations contributes to lower operating costs, more accurate forecasting, improved resource utilization, and greater supply chain resilience in highly turbulent business environments (Gartner, 2024; McKinsey Global Institute, 2024).

Despite the substantial body of research devoted to the digital transformation of logistics, supply chain management, and supply chain resilience, the comprehensive application of artificial intelligence and predictive analytics to logistics risk forecasting remains insufficiently explored. Further research is needed to develop methodological approaches for integrating AI into logistics risk management systems, designing machine learning and big data-based forecasting models, and evaluating their practical effectiveness in contemporary business operations (Wieland & Durach, 2021; Queiroz & Fosso Wamba, 2023). These research gaps justify the relevance of the present study and highlight the need for further advances in digital approaches to supply chain resilience management.

Modern supply chains operate under conditions of significant uncertainty resulting from geopolitical conflicts, climate change, pandemics, and the digital transformation of the economy. Consequently, organizations must move beyond traditional reactive approaches to logistics risk management toward proactive forecasting and prevention strategies (Sheffi, 2024; Ivanov, 2024; Wieland & Durach, 2021).

Artificial intelligence and predictive analytics represent some of the most effective technologies for achieving this transition. The application of machine learning algorithms, big data analytics, the Internet of Things (IoT), and digital platforms enables organizations to identify emerging risks at an early stage, forecast delivery delays, optimize transportation routes, evaluate supplier reliability, and support managerial decision-making (Queiroz & Fosso Wamba, 2023; Büyüközkan & Göçer, 2021; Sanders, 2023; Chopra, 2024).

Unlike traditional statistical models, predictive analytics forecasts future events by combining historical information with real-time data streams. This capability enables organizations to adopt proactive logistics risk management strategies and enhance supply chain resilience (Sanders, 2023; McKinsey Global Institute, 2024; Jahin et al., 2024).

Therefore, the integration of artificial intelligence and predictive analytics has become one of

the principal directions in the evolution of modern logistics, providing more accurate risk forecasting, reducing logistics costs, and increasing organizational adaptability to changes in the external environment (Gartner, 2024; Deloitte, 2025; DHL, 2024; IBM, 2024).

The effectiveness of logistics risk forecasting largely depends on the quality of data analysis and the ability of information systems to identify potential threats in a timely manner. In contemporary supply chains, AI algorithms are increasingly employed to automate the processing of large-scale datasets and generate real-time forecasts (Queiroz & Fosso Wamba, 2023; Simchi-Levi et al., 2023).

Among the most widely adopted AI techniques in logistics are machine learning, artificial neural networks, decision trees, Random Forest, XGBoost, and time-series forecasting algorithms. These models support the prediction of delivery delays, demand fluctuations, inventory shortages, transportation infrastructure congestion, supplier-related risks, and potential disruptions to logistics routes (Queiroz & Fosso Wamba, 2023; Büyüközkan & Göçer, 2021).

The integration of AI with big data, the Internet of Things (IoT), GPS tracking, RFID technologies, and Enterprise Resource Planning (ERP) systems further enhances forecasting accuracy. Combining data from multiple sources enables the rapid detection of operational deviations and facilitates timely managerial decisions aimed at mitigating logistics risks (National Institute of Standards and Technology, 2023). Consequently, AI technologies fundamentally transform logistics risk management by shifting the focus from analyzing past events to predicting and preventing future disruptions. This transformation contributes to more efficient supply chain management, lower logistics costs, and stronger resilience under conditions of environmental uncertainty (Sheffi, 2024; Ivanov, 2024; Gartner, 2024; Deloitte, 2025).

3. Comparative Analysis of Theories

The United States is one of the global leaders in implementing artificial intelligence and predictive analytics in logistics. Leading companies extensively apply intelligent algorithms to forecast risks, optimize transportation routes, manage inventories, and strengthen supply chain resilience (Gartner, 2024; McKinsey Global Institute, 2024; Deloitte, 2025). Amazon employs AI for demand forecasting, automated inventory management, and logistics route optimization, thereby reducing delivery times and minimizing the risk of supply disruptions (Amazon Web Services, 2024). UPS utilizes its ORION system, which applies AI-based algorithms to analyze traffic conditions, transportation flows, and other operational factors to determine optimal delivery routes and reduce the likelihood of delays (UPS, 2024). FedEx employs predictive analytics to forecast potential delivery disruptions, optimize logistics operations, and provide customers with timely updates throughout the transportation process (FedEx, 2024). Walmart uses machine learning algorithms for demand forecasting, inventory management, and logistics center coordination, enabling the company to respond rapidly to changing market conditions and improve the efficiency of supply chain management (Walmart Inc., 2025).

Technological companies such as IBM, Oracle, and Microsoft play a pivotal role in the digital transformation of logistics by developing cloud-based artificial intelligence platforms for supply chain monitoring, risk assessment, and decision support (IBM, 2024; Oracle, 2024; Microsoft, 2024). Evidence from leading U.S. companies demonstrates that the integration of artificial intelligence technologies significantly improves forecasting accuracy, reduces operating costs, enhances the adaptability of logistics systems, and strengthens supply chain resilience under conditions of high uncertainty (McKinsey Global Institute, 2024; Gartner, 2024).

4. Integrating Artificial Intelligence (AI) and Predictive Analytics into Logistics Risk Management Systems

Based on a synthesis of contemporary scientific approaches and an analysis of practices adopted by U.S. enterprises, this study proposes a conceptual framework for integrating Artificial Intelligence (AI) and Predictive Analytics into logistics risk management systems (Figure 1). The proposed framework integrates data collection and aggregation, intelligent data processing, logistics risk forecasting, impact assessment, and managerial decision support within a unified digital environment.

The proposed framework consists of several sequential stages: collecting data from internal and external sources (ERP, WMS, TMS, IoT

devices, GPS systems, market intelligence, and weather data); integrating and preparing the data for analysis; applying machine learning algorithms to predict logistics risks; assessing the potential consequences of identified risks; generating managerial decisions; and continuously improving forecasting models based on newly acquired data.

Unlike conventional approaches, the proposed framework not only enables the timely identification of potential threats but also supports the prediction of alternative logistics scenarios, thereby facilitating a transition from reactive to proactive risk management. Its implementation improves forecasting accuracy, reduces logistics costs, minimizes losses caused by supply chain disruptions, and enhances supply chain resilience under conditions of high uncertainty (Queiroz & Fosso Wamba, 2023; National Institute of Standards and Technology).

6. Conclusions

The findings demonstrate that Artificial Intelligence and Predictive Analytics represent one of the key directions in the evolution of modern logistics risk management systems. Unlike traditional analytical methods, AI enables the early identification of potential threats, the prediction of supply chain disruptions, and data-driven managerial decision-making based on the analysis of large-scale datasets. Consequently, organizations can shift from reactive to proactive risk management while improving the adaptability and resilience of logistics systems in highly uncertain environments (Sheffi, 2024; Ivanov, 2024).

The study also reveals that leading U.S. companies actively integrate AI and Predictive Analytics into demand forecasting, inventory management, transportation route optimization, supplier risk assessment, and business continuity management. The practical experience of Amazon, UPS, FedEx, Walmart, IBM, Oracle, and Microsoft demonstrates the effectiveness of intelligent analytics in strengthening supply chain resilience, reducing operational costs, and improving logistics management performance (IBM, 2024; Oracle, 2024; Microsoft, 2024).

STAGE	MAIN FOCUS	KEY ACTIVITIES
1. DATA SOURCES	Collecting relevant data from internal and external sources	• ERP, WMS, TMS, CRM data • IoT and operational data • Supplier and customer data • External data (weather, traffic, market) • Other relevant data
2. DATA INTEGRATION & PREPARATION	Preparing data for analysis and modeling	• Data collection and integration • Data cleaning and validation • Data transformation • Data normalization • Feature engineering
3. AI & PREDICTIVE ANALYTICS	Applying AI techniques to predict risks	• Machine learning models • Predictive analytics • Time series forecasting • Scenario analysis • Risk prediction models
4. LOGISTICS RISK FORECASTING	Identifying and forecasting potential logistics risks	• Risk identification • Probability assessment • Impact evaluation • Risk forecasting • Alternative scenario analysis
5. DECISION SUPPORT & MANAGEMENT ACTIONS	Supporting decision-making and risk mitigation	• Route optimization • Inventory optimization • Supplier selection • Risk mitigation planning • Automated decision support
6. MONITORING & FEEDBACK LOOP	Monitoring performance and improving models	• Real-time monitoring • Performance evaluation • Model updating • Continuous improvement
RESULT	Achieving stronger, more resilient supply chains	• Enhanced supply chain resilience • Reduced logistics costs • Improved forecast accuracy • Faster decision-making • Increased operational efficiency • Sustainable competitive advantage

Figure 1. Conceptual Model for Integrating AI and Predictive Analytics into Logistics Risk Management

Future research should focus on the development of mathematical models for evaluating the effectiveness of AI applications in logistics systems, the integration of generative artificial intelligence and digital twins into logistics risk forecasting, and the adaptation of advanced AI-driven solutions to the needs of Ukrainian enterprises in the context of digital transformation and post-war economic recovery.

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