

# Predictive Maintenance and Risk Management in Logistics Using AI



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# Predictive Maintenance and Risk Management in Logistics Using AI

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## **Abstract**

In the evolving logistics industry, managing risks efficiently has become a critical concern for organizations striving for operational excellence and resilience. Traditional risk management approaches often fall short in addressing the dynamic and complex nature of modern supply chains, prompting the integration of Artificial Intelligence (AI) and advanced data analytics to enhance risk identification, assessment, and mitigation. This chapter explores the application of AI-based risk management systems in logistics, focusing on the identification of operational, strategic, and cyber risks, and the significant role of predictive analytics in forecasting potential disruptions. AI algorithms, including machine learning, deep learning, and anomaly detection models, are discussed as key tools for real-time risk assessment and decision-making, enabling proactive measures to prevent system failures and supply chain disruptions. The chapter also highlights the synergy between Internet of Things (IoT) devices, sensor technologies, and AI in creating a comprehensive risk management framework that ensures optimal performance and minimizes operational downtime. Challenges and future directions in the integration of AI with existing logistics systems are examined, along with the quantification and prioritization of risks through data-driven models. Ultimately, the chapter emphasizes the shift from reactive to proactive risk management strategies, showcasing the potential of AI to transform risk management in logistics and supply chain operations.

**Keywords:** Risk Management, Artificial Intelligence, Predictive Maintenance, Supply Chain Disruptions, Machine Learning, Internet of Things (IoT).

## **Introduction**

The logistics industry faces increasing pressure to manage risks effectively, as modern supply chains grow more complex and interconnected [1]. Traditional risk management strategies, which largely depend on manual intervention, expert judgment, and historical data, are increasingly inadequate to handle the dynamic and unpredictable nature of contemporary logistics operations [2]. With the advent of digital technologies, organizations are turning to advanced tools, such as Artificial Intelligence (AI), to enhance their ability to identify, assess, and mitigate risks in real-time [3]. AI-driven risk management systems enable logistics companies to gain a deeper understanding of the multitude of risks they face, including operational, strategic, and cyber risks [4]. By leveraging machine learning algorithms and predictive analytics, AI provides a proactive approach to risk management, enabling organizations to address potential disruptions before they materialize into costly problems [5].

Operational risks, such as equipment failures, transportation delays, and supply chain inefficiencies, can severely disrupt logistics operations and lead to increased costs, missed deadlines, and reduced customer satisfaction [6]. AI-powered predictive maintenance tools are increasingly used to predict and prevent such failures [7]. By continuously monitoring equipment performance through IoT sensors and analyzing historical maintenance data, AI algorithms can forecast when maintenance is required, thereby minimizing the likelihood of unplanned downtime [8]. This predictive approach to maintenance helps logistics companies optimize their asset usage, reduce operating costs, and improve overall reliability in their operations [9]. In contrast to traditional methods, which rely on scheduled maintenance and reactive repairs, AI enables logistics companies to shift toward more efficient, data-driven maintenance practices [10].

Strategic risks are broader and more complex, involving external factors such as regulatory changes, market fluctuations, and shifts in consumer behavior [11]. These risks require a long-term, forward-thinking approach, which is difficult to achieve with traditional risk management techniques [12]. AI systems are uniquely positioned to address strategic risks by providing data-driven insights into market trends, customer demand patterns, and competitive dynamics [13]. Machine learning models can analyze historical data alongside current market conditions to forecast potential disruptions or opportunities, allowing logistics companies to make better-informed decisions [14]. For example, AI can help companies anticipate supply chain disruptions caused by new tariffs, trade policies, or geopolitical instability, enabling them to take preemptive actions and mitigate the effects of such changes [15].