Chapter 1
Artificial Intelligence and IoT Integration in Supply Chains:
A Strategic Framework for Smart, Adaptive, and Sustainable Operations

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ABSTRACT

This chapter explores the convergence of Artificial Intelligence (AI) and the Internet of Things (IoT) in transforming supply chain operations for sustainability. It presents a layered framework where smart sensors, GPS trackers, and RFID devices collect real-time data, processed through AI/ML algorithms to drive optimization in logistics, inventory, and resource management. Case studies in agriculture and retail demonstrate significant improvements in yield, fuel savings, and carbon emission reductions. The framework emphasizes a feedback loop for continuous learning, enabling adaptive and resilient supply chain systems. The chapter also discusses ethical, regulatory, and interoperability challenges, proposing future

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research directions including blockchain integration and Edge AI. It serves as a comprehensive guide for researchers, practitioners, and policymakers aiming to build smart, data-driven, and sustainable supply chains.

INTRODUCTION

In the modern dynamic industrial world, Artificial Intelligence (AI) and the Internet of Things (IoT) converge and turn the traditional supply chain paradigms into intelligent, sustainable and highly responsive ecosystems. The trend on environmental protection, economic performance, and societal efforts to be more responsible are global, and the industries have been compelled to rethink how they operate, and an entity as AI and IoT may prove instrumental in transforming the stagnant supply chains to dynamic ones that run on data. These technologies enable real-time monitoring, intelligent prediction and autonomous decision-making- less wastage, more productiveness and more use of resources in the supply chain. AI can be applied to supply chain to create predictive analytics, demand forecasting, anomaly detection and optimization, and IoT devices, e.g. sensors, RFID tags, GPS trackers can be used to create live visibility in the supply chain and traceability at various stages of the operation (Udeh et al., 2024). This, as a collective, provides a powerful cyber-physical system capable of sensing, interpreting and acting on real-world data to facilitate basic sustainability trends like carbon emission, energy savings and circular supply chains. This chapter examines the use of new operational agility via AI and IoT to transcend support to sustainable practice, offers a general conceptualization that can guide all stakeholders in the agricultural sector, manufacturing sector, logistics sector and retail sector to future proof their supply chains.

Role of AI in Supply Chain Optimization

Artificial Intelligence can be used to offer an unprecedented increase of the supply chain by introducing automation, 20/20 vision, and intelligence as a means of re- credentialization. Machine learning algorithms allow AI systems to process big data over a long-time span not only of the current time but also of the past, and provide valid predictions of the demand, maximum inventory and minimal lead time and supply chain failures (Kadhim Obaid et al., 2024). One such case would be the use of AI-based forecasting that could prevent the threats of surplus production or stockouts leading to energy-efficient and cost-effective operations. Reinforcement learning can also dynamically change the scheduled procurement and production owing to changes in demand over time and supplier capabilities. In addition, decision support systems based on AI facilitate multi-objective optimization, e.g. cost, time,