Chapter 1
Big Data–Enabled Transformation of Global Supply Chains:
Integrating IoT, AI, XAI, and Governance for Sustainable and Resilient Operations

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ABSTRACT

This chapter examines how big data analytics is reshaping global supply chains by enabling a shift toward sustainability, resilience, and responsible decision-making. It explores the integrative roles of Internet of Things (IoT) generated data, artificial intelligence (AI), and explainable AI (XAI) in enhancing visibility, predictive capability, and managerial accountability across complex supply networks. The

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discussion highlights how data-driven insights support energy efficiency, emissions reduction, risk anticipation, and adaptive operational responses, while emphasizing the importance of governance frameworks in addressing cybersecurity, data privacy, and ethical concerns. By synthesizing technological, managerial, and policy perspectives, the chapter demonstrates that sustainable and resilient supply chain transformation depends not only on advanced analytics but also on transparency, trust, and robust data stewardship in an increasingly digitalized global environment.

INTRODUCTION

The present context of global trade has experienced a shift in supply chain to become dynamic connected socio-technical ecosystem where sustainability and resilience have become the important methods. The combination of the Big Data Analytics (BDA), Internet of Things (IoT), Artificial Intelligence (AI), Explainable AI (XAI), and powerful governance systems, are reshaping the design, management, and transformation of supply chains. The growing rate of digitization has increased the volume, rate and range of data generated at various points of contact within the supply chain that facilitates real-time visibility and analytic insights previously unavailable. Sensors, corporate systems, logistics, and external entities produce data streams that are used to make both strategic and operational decisions through these digital ecosystems which simultaneously meet sustainability objectives and enhance dynamic capability to shocks. The blistering increase in the amount of data and blistering development of AI and machine learning (ML) approaches and design forced researchers and practitioners to redesign the supply chain models found on the data-centered paradigm. BDA and AI have not only become widely acceptable as a means of optimization of the operations but also as important models in developing smart supply chains that provide predictive and prescriptive decisions and efficiencies in resource deployment, and an improved environmental output. As the latest research states, supply chain resilience and the facilitation of sustainable practices across the majority of industries is possible because of the integration of the BDA and AI since these tools allow predictive risk mitigation and more adaptive responses to volatility (Kamble et al., 2023; Kumar et al., 2024; Talwar et al., 2021). The development is consistent with the global practices of sustainability and governance where there is need for transparency, accountability and ethical data and decision-making practices.

This rate notwithstanding, complex analytics adoption in global supply chains is a huge load especially in interpretation of complex model outputs, information security, and ethical integrity. To curb such concerns, the idea of XAI has come out as an important area of research that will render AI-generated information com-

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