Chapter 9

# Quantum-Inspired Big Data Analytics for Sustainable and Resilient Global Supply Chains

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## ABSTRACT

*The escalating complexity of global supply chains requires analytical capacity beyond that traditionally offered by big data systems. With such disturbances as pandemics, climate shocks and geopolitical tensions growing in scale and intensity, the simultaneous pursuit of sustainability and resilience has emerged as a key strategic challenge. In this chapter, the authors study how quantum-inspired big data analytics can be leveraged to facilitate sustainable and resilient global supply chain systems. Based on the synthesis of Resilience Theory, Complex Systems Theory and Sustainability Frameworks, the research propose a conceptual framework that demonstrates how quantum-inspired algorithms contribute to predictive modelling, decision optimisation and risk intelligence.*

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## INTRODUCTION

Fueled by rapid globalization, increasing regulatory burdens, technological disruption, and an evolving set of sustainability requirements from end consumers, governments, and investors, global supply chains have been undergoing a steady expansion of complexity and fragility in recent years. The need for sustainability has become a challenge for supply chains to not only efficiently provide products and services but also have minimal impact on the environment, be socially responsible, and have economic sustainability. Meanwhile, resilience—the capability of a supply chain to foresee, adjust to, bounce back from, and grow from disruptive events—has gained prominence as a high-priority strategic consideration in light of ongoing challenges to global logistics networks posed by the likes of the COVID-19 pandemic, natural disasters, geopolitical instability, and supply constraints (Iftikhar et al., 2024).

Conventional BDA has already made great strides in supply chain management, providing mechanisms for visibility in real-time, demand prediction, inventory management, logistics optimization, and supplier risk analysis (Salwa, 2024; Bag et al., 2020). These functions have been at the heart of firms' ability to track performance, uncover patterns, and make informed decisions. Yet for all these achievements, the challenges facing traditional analytics are now plain in the scale and complexity of today's global networks. Big data methods tend to face challenges for high-dimensional, interrelated, and dynamic systems like multi-tier supply chains, where local disruptions (supply shortages, environmental disasters, economic downturns, etc.) might cascade and be magnified across geographies and time. For instance, although BDA improves forecasting and visibility, systematic reviews report that the exploitation of BDA to foster supply chain resilience is fragmented and in its infancy (Zamani et al., 2023; Dubey et al., 2022). Moreover, with sustainability goals, analytics must go beyond operational efficiency to include multi-objective optimization (economic, environmental, social) and the management of the inevitable trade-offs between performance and responsibility. However, many of the existing BDA techniques continue to be reactive as opposed to adaptive, concentrating on detection and reaction rather than proactive scenario-planning, optimization under uncertainty, or system redesign for resilience and sustainability (Jiang et al., 2025).

Quantum-inspired analytics have started gaining attention as a computational flow suitable for the next generation of computing approaches to overcome some of these challenges. Although large-scale quantum computing is still in its infancy, quantum-inspired methods are based on some fundamental aspects of quantum mechanics—e.g., superposition, entanglement and parallelism— but are executed on classical computing platforms (Munim et al., 2024; Vudugula et al., 2025). These techniques allow for the investigation of extremely large solution spaces, the

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