Chapter 8
Intelligent Logistics: Generative AI, Digital Twins, and Autonomous Supply Chains in GCC and Beyond

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ABSTRACT

This chapter examines how generative AI, digital twins, and autonomous operations are reshaping logistics into intelligent, sustainable, and resilient ecosystems, with emphasis on GCC and MENA contexts. Generative AI supports forecasting, disruption management, and procurement optimization, while digital twins enable real-time simulation, predictive analytics, and ESG tracking. Autonomous operations using robotics, drones, AGVs, and AI-driven control towers boost efficiency, transparency, and safety. Case studies from the UAE, Saudi Arabia, Qatar, and Oman highlight applications in healthcare, ports, food security, and green trade corridors. Beyond technology, the chapter underscores ethical AI, cyber-physical security, and carbon-neutral strategies. It shows how GCC nations, through digital infrastructure and visionary policies, are advancing future-ready logistics. The chapter provides actionable frameworks linking research, industry, and governance to enable resilient, transparent, and sustainable supply chains.

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INTRODUCTION

Driven by Artificial Intelligence (AI) along with digital twins and autonomous operations, logistics and supply chains are evolving. Agile, sustainable, and resilient ecosystems are gradually replacing traditional linear models which focused solely on data. AI predictive and prescriptive analytics and resource optimization with the combination of Generative AI and cyber-physical systems are instantaneous. Organizations can now use digital twins to model and monitor disruptions, resource optimization, emissions of activities, and carbon emissions in the supply chain. At the same time, autonomous systems replace logistics hubs with self-optimizing drones, robotic, AI-enabled control towers, and others. Such transformations are pivotal to the Gulf Cooperation Council and the MENA such regions are pivotal to enhancing the economic value of logistics. This chapter provides an optimistic case studies of the Gulf Cooperation Council and MENA regions to craft transparent, resilient, and sustainable supply chains to refer frameworks (Aliahmadi et al., 2022).

Evolution of Logistics and Supply Chains in the Digital Era

The progress of logistics and rife trade has evolved extensively over the centuries with the Internet of Things and Big Data having broken borders with unparalleled operational and transactional capabilities and transformed manual systems to 'Digital and Automated nations'. Supply chains are entirely ecosystem integrated to digitally rooted fore and operate chains which in turn improves accuracy in automated predictive planning and forecasting and greatly simplifies ordering systems due to decreased overhead and operational costs. Process technologies such as drones and complex robotic systems which do the least human-controlled processes remarkably enhance transactional system speed and accuracy due to the minimal human errors. Global and climate change has had a profound impact on governance and operational systems on trade due to the sustainable strategies and global Carbon release accountabilities. It has made the systems intelligent as well, able to balance the ecosystem with the sustainable self-adapting system capable of preserving supply chains. Shifts have also been made in the Middle East and the series. Shifts have also been made in the GCC and Middle Eastern region (Lai, 2024). Figure 1 Illustrates the progression of logistics from cost reduction to globalization, digital adoption, AI-driven optimization, autonomy, and sustainability integration. Table 1 Shows how supply chains have moved from manual, cost-focused systems to smart, data-driven networks powered by AI, digital twins, and automation, ending in sustainable and intelligent logistics.