Chapter 1
Transformative Impact of AI on Pharmaceutical Supply Chain Management: Revolutionizing Agility Through Dynamic Capabilities, IBP, and S&OP

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ABSTRACT

The pharmaceutical supply chain is characterized by mounting intricacy and the necessity for expeditious responses to fluctuating market conditions, regulatory constraints, and disruptions. The advent of Artificial Intelligence (AI) has been identified as a transformative force, with the potential to enhance organizational agility through dynamic capabilities (DC), Integrated Business Planning (IBP), and Sales and Operations Planning (S&OP). This chapter develops a comprehensive theoretical framework to examine the intersection of AI, pharmaceutical supply chain management, and DC, addressing a critical gap in understanding how AI-driven technologies can revolutionize agility and strategic alignment.

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INTRODUCTION

The pharmaceutical and biotechnology sectors currently face significant supply chain management challenges, driven by the need for greater agility, resilience, and adherence to complex regulatory standards. Inefficiencies in Integrated Business Planning (IBP) and Sales and Operations Planning (S&OP) hinder these sectors from meeting the dynamic demands of modern supply chains, leading to misaligned resource allocation, suboptimal demand forecasting, and reduced adaptability that jeopardize both operational sustainability and public health outcomes. Addressing these issues extends beyond operational improvements; the industry's global health implications necessitate sophisticated frameworks that support agility, regulatory compliance, and innovation. Artificial Intelligence (AI) holds promise in revolutionizing decision-making through predictive analytics, real-time visibility, and adaptive planning. However, the theoretical integration of AI into traditional supply chain frameworks remains fragmented, with critical gaps in understanding its mechanisms and outcomes (Bhattamisra et al., 2023). Bridging these gaps is essential for developing intelligent, adaptive, and sustainable supply chain practices that balance operational goals with ethical imperatives. While existing literature demonstrates the value of AI in enhancing predictive analytics, operational efficiency, and visibility, it falls short of addressing its role in reinforcing digital continuity within pharmaceutical supply chains. Traditional supply chain theories provide insights into process optimization and resilience but lack integration with advanced technological innovations. Recent studies on digital transformation have yet to fully explore how AI-enabled frameworks can operationalize IBP and S&OP to meet contemporary challenges. Moreover, research on sustainability and ESG (Environmental, Social, and Governance) reporting in supply chain management often treats these dimensions separately, ignoring their convergence with AI-driven capabilities (Ahmed et al., 2020; ElBaih, 2023).

This chapter seeks to fill these voids by proposing a unified theoretical framework that integrates AI technologies with IBP, S&OP, and digital continuity. The primary objective is to elucidate how AI can enhance agility and strategic alignment in pharmaceutical supply chains, while supplementary goals include examining the evolution of these frameworks and evaluating their conformity with corporate sustainability and ESG mandates. The study addresses the central research problem of the absence of a cohesive framework that merges AI-driven innovations with traditional supply chain practices under sustainability imperatives, focusing on how existing theories of IBP, S&OP, and digital continuity account for current limitations and identifying key components for an integrated conceptual model. Employing a concept-based theoretical research methodology grounded in extensive literature review and synthesis of peer-reviewed articles, industry reports, and case studies,