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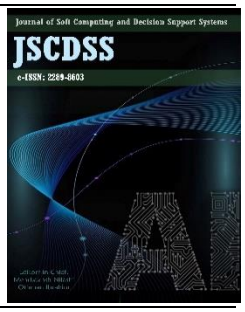

The Role of Big Data in Supply Chain Improvement: A Discussion Paper

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Abstract

Big data has emerged as a transformative force in supply chain management, enabling organizations to derive insights from large, diverse, and rapidly generated datasets. By applying advanced analytics to this information, supply chains can enhance forecasting, inventory control, logistics coordination, and risk mitigation. Key enabling technologies such as the Internet of Things, cloud computing, and artificial intelligence provide the infrastructure for improved visibility and decision-making. This paper discusses the role of big data in supply chain improvement, reviews relevant literature, and examines technological foundations alongside common applications. Challenges including data quality, integration complexity, security, and skill shortages are also addressed. Finally, the paper outlines future research directions and technological trends such as prescriptive analytics, digital twins, and sustainability-focused practices. The discussion highlights how big data can enable more efficient, adaptive, and resilient supply chains when both technical and organizational barriers are effectively managed.

Keywords: Big Data, Supply Chain, Supply Chain Management, Machine Learning, Digital Twins

1. Introduction

Modern supply chains operate in highly dynamic global markets [1-4], making efficiency and adaptability crucial competitive factors. Supply chain planning involves "the set of processes and activities related to the development of plans to guide the operation of supply chains" by translating demand requirements into feasible production and distribution programs [5-7]. Traditionally, supply chains often struggled with uncertain demand and complex logistics, but the explosion of data in recent years has begun to change this paradigm. As the authors in [5] note, the exponential growth of accessible data means that planning activities—from demand forecasting to inventory allocation—are "significantly affected by the advancement of digital technologies and analytics" [5]. In other words, organizations now have a wealth of information (from internal systems, suppliers, market sensors, social media, etc.) that can be mined to improve supply chain decisions.

Big data analytics (BDA) refers to the application of advanced methods [8-10] (such as machine learning, data mining, and predictive modeling) to very large, diverse datasets characterized by high volume, variety, velocity, value, and veracity [5, 11-13]. In a supply chain context, BDA enables firms to extract patterns and predictive insights from data streams that were previously too large or unstructured for traditional tools [5, 14]. For example, IoT sensors, RFID tags, and enterprise software generate continuous streams of data on production outputs, shipments, and point-of-sale transactions. Advanced analytics systems can process this information in real time, enhancing visibility and enabling proactive responses to disruptions. Lin (2024) observes that big data technologies "can process massive amounts of data quickly and efficiently, revealing potential patterns and risks in the supply chain" [15]. McKinsey research also reports that use of big data analytics enables supply chain cost reductions (~15%) and significantly lower inventory backlogs (20–30%) [15]. These improvements translate into faster deliveries, lower carrying costs, and more resilient operations.

The growing relevance of big data in supply chains is evident in the increasing volume of recent scholarly work [14, 16-21]. Studies confirm that BDA has been applied across supply chain functions and continues to draw intense research attention. At the same time, experts note gaps in understanding how to align big data investments with specific planning needs [5]. This paper aims to synthesize current knowledge on big data in supply chain improvement. We first survey the literature on BDA adoption in supply chains, then examine enabling technologies and common applications (forecasting, inventory, logistics, risk management). We present case examples from the literature (e.g. Amazon, Alibaba, Walmart, UPS) illustrating real-world outcomes. We then discuss challenges and limitations (such as data quality, security, and skill shortages) and conclude with future trends (e.g. AI integration, digital twins) to guide researchers and practitioners.