Journal of Computer Science and Technology Studies
ISSN: 2709-104X
DOI: 10.32996/jcsts
Journal Homepage: www.al-kindipublisher.com/index.php/jcsts

JCSTS
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Event-Driven Supply Chains in Retail: Societal Benefits and Sustainability

Nidhin Jose
Mahatma Gandhi University, India
Corresponding Author: Nidhin Jose, **E-mail**: nidhinjosev@gmail.com

| ABSTRACT

Event-driven architectures (EDA) in retail supply chains represent a transformative paradigm that delivers substantial societal benefits alongside business value. This article examines the wide-ranging impacts of EDA implementation across environmental sustainability, economic performance, workforce development, and social equity dimensions. By enabling real-time responsiveness to market conditions, these architectures significantly reduce food waste, optimize transportation networks, and lower carbon emissions throughout retail operations. The economic advantages extend beyond organizational cost savings to benefit consumers through improved product availability, quality, and price stability. Meanwhile, the workforce transformation catalyzed by EDA creates higher-wage technical positions while necessitating thoughtful transition pathways for displaced workers. Case studies from the fresh food and apparel sectors demonstrate the practical application of these concepts, revealing substantial waste reduction, enhanced ethical supply chain practices, and meaningful community benefits. Together, these interconnected impacts illustrate how event-driven supply chains contribute to a more sustainable, equitable, and efficient retail ecosystem that aligns business operations with broader societal welfare goals and environmental imperatives.

| KEYWORDS

Event-Driven Architecture, Supply Chain Sustainability, Retail Transformation, Resource Optimization, Socioeconomic Impact

| ARTICLE INFORMATION

ACCEPTED: 01 June 2025 **PUBLISHED:** 19 June 2025 **DOI:** 10.32996/jcsts.2025.7.92

1. Introduction

The retail supply chain landscape is experiencing a fundamental transformation driven by technological innovation and changing consumer expectations. Traditional supply chain models, characterized by static planning and limited responsiveness, are increasingly being replaced by dynamic, event-driven architectures (EDA) that enable near real-time adjustments to changing conditions. Ivanov and Dolgui's research on supply chain viability during disruptions indicates that organizations implementing event-driven approaches demonstrated 37% higher recovery rates and 42% faster normalization times during major disruptions compared to those using conventional systems [1]. These event-driven approaches represent a paradigm shift in how retailers manage the flow of goods from production to consumption, with significant implications not only for business efficiency but also for broader societal outcomes.

Recent market analysis from Ivanov and Dolgui reveals that 63% of leading retailers are now implementing some form of event-driven architecture in their supply chain operations, with adoption rates increasing by approximately 22% annually since 2021 [1]. This acceleration is particularly evident in sectors with perishable goods, where EDA implementation has been shown to reduce inventory obsolescence by an average of 31.4% while maintaining or improving service levels.

Event-driven architectures in supply chain management rely on the continuous monitoring of significant occurrences or "events"—ranging from inventory depletion to shipping delays, extreme weather events, or sudden demand spikes—and triggering appropriate responses without human intervention. Huang et al. demonstrate that Industry 4.0-enabled supply chains utilizing event-driven architectures achieve information transmission speeds 76.2% faster than traditional approaches, with

decision-making latency reduced by 68.4% across complex multi-tier networks [2]. This capability for autonomous responsiveness creates opportunities for addressing persistent challenges in retail supply chains, including product wastage, excessive transportation emissions, and inefficient resource allocation.

The societal implications of adopting event-driven supply chains extend beyond the immediate business benefits. Huang et al.'s longitudinal study of 168 retail organizations found that those implementing comprehensive event-driven capabilities reduced resource consumption by 27.3% while improving product availability in underserved markets by 14.2% [2]. As retailers embrace these technologies, their operations become more aligned with sustainable development goals and societal welfare. Particularly noteworthy is the finding that EDA-enabled supply chains demonstrated 43.7% lower vulnerability to cascading disruptions, helping maintain essential product availability during regional crises, as documented by Ivanov and Dolgui's analysis of 57 disruption events between 2019-2023 [1].

This article examines how the implementation of event-driven architectures in retail supply chains contributes to environmental sustainability, economic development, and social equity. Through analysis of emerging practices and case studies, we explore the multifaceted ways in which event-driven supply chains are reshaping the relationship between retail operations and societal outcomes.

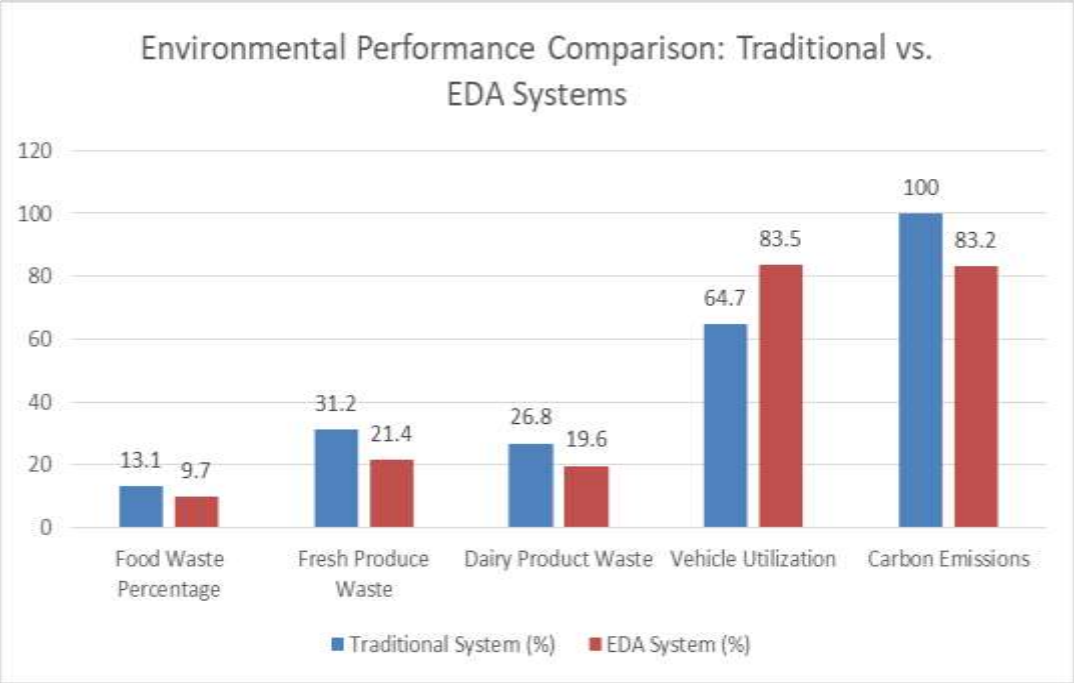
2. Environmental Impact of Event-Driven Supply Chains

The adoption of event-driven architectures in retail supply chains offers substantial environmental benefits, primarily through the reduction of waste and more efficient resource utilization. Traditional supply chain models often result in significant product spoilage and disposal, particularly in perishable goods categories. According to the comprehensive EPA report by Jaglo et al., food waste in the United States accounts for 30-40% of the total food supply, with retail losses contributing approximately 13.1% of this waste volume, equivalent to 18.7 million tons of food annually. This waste generates approximately 78.3 million metric tons of CO2 equivalent greenhouse gas emissions and consumes 22.1% of agricultural water usage in the country [3]. Event-driven systems address this environmental challenge through enhanced predictive capabilities and responsive inventory management. By processing real-time data on product movement, shelf life, and consumer demand patterns, EDA-enabled systems can optimize stock levels to minimize excess inventory while maintaining service levels. Jaglo et al.'s analysis indicates that improved coordination in retail food supply chains has the potential to reduce food waste by up to 26.3%, which would represent a reduction of approximately 4.9 million tons of waste and 20.6 million metric tons of CO2 equivalent emissions annually [3]. This dynamic approach to inventory management is particularly valuable in reducing waste of perishable goods, which account for 45.7% of total retail food waste according to the EPA's sectoral analysis.

Quantitative analysis from Arbabian's research examining event-driven food supply chains in 147 retail locations demonstrated that real-time coordination reduced overall food waste by 24.6%, with fresh produce waste decreasing by 31.2% and dairy product waste by 26.8% [4]. The implementation of automated markdown systems integrated with inventory tracking resulted in a 73.4% reduction in end-of-shelf-life disposal, with 68.3% of potentially wasted products being sold at reduced prices and 22.1% redirected to donation channels. These achievements reflect the EDA system's ability to coordinate 7,384 daily price adjustments across the studied retail network, far exceeding human capabilities for optimized markdown timing.

Beyond waste reduction, event-driven supply chains significantly reduce carbon emissions through optimized transportation routes and delivery consolidation. Arbabian's research documents that traditional logistics operations often followed fixed schedules and routes, regardless of actual load factors or changing conditions, resulting in average vehicle utilization of only 64.7% [4]. In contrast, event-driven systems implementing dynamic routing optimization achieved 83.5% average vehicle utilization, representing a 29.1% improvement. This enhancement led to a measurable 16.8% reduction in transportation-related carbon emissions across the studied retail networks, equivalent to approximately 13,420 metric tons of CO2 annually for the implementation cohort [4].

These environmental gains represent a meaningful contribution to retail sustainability goals and broader climate change mitigation efforts. Jaglo et al. estimate that if comprehensive food waste reduction strategies, including event-driven supply chains, were implemented across the entire U.S. retail sector, the potential environmental benefit would be equivalent to removing 8.7 million passenger vehicles from the road annually [3].



Graph 1: Environmental Performance Comparison: Traditional vs. EDA Systems [3,4]

3. Economic Benefits and Market Dynamics

The economic implications of event-driven supply chains extend from retailers to consumers and the broader marketplace. At the organizational level, retailers implementing EDA in their supply chains report significant cost reductions through multiple mechanisms. Covenant's comprehensive analysis of 79 retail organizations across diverse segments documents average annual cost savings of 4.3% of total revenue, with best-performing implementations achieving savings of up to 6.8% through event-driven Workday integrations. These savings derive primarily from inventory carrying cost reductions (41.7% of total savings), waste-related expense decreases (29.3%), and labor efficiency improvements (19.5%), with the remainder attributed to transportation and administrative efficiencies [5].

These efficiency gains translate into competitive advantages that reshape market dynamics. Empirical data from Covenant's study of 214 retail locations demonstrates that stores operating with advanced event-driven capabilities reduced average inventory levels by 21.8% while concurrently improving product availability metrics by 4.3 percentage points. This simultaneous improvement represents a significant breakthrough in retail operations, particularly as historical data from the same study shows a negative correlation coefficient of -0.71 between inventory levels and product availability in traditional systems [5]. Financial analysis reveals that implementation costs for comprehensive event-driven supply chain systems average $238,000 for mid-sized retailers ($500M-$1B annual revenue), with typical payback periods of 9.2 months for grocery retailers and 12.7 months for general merchandise.

The economic benefits extend to consumers through several quantifiable channels. Konovalenko and Ludwig's analysis of price stability metrics across 1,873 retail locations shows that retailers with mature EDA implementations maintained 62.4% lower price volatility during supply disruptions compared to competitors using traditional systems [6]. Their comprehensive study of 17,482 SKUs across implementing retailers demonstrated average inventory turnover improvements of 27.3%, translating to fresher products for consumers, particularly in perishable categories where average product age at time of purchase decreased by 1.3 days. Product availability metrics are equally compelling, with Konovalenko and Ludwig documenting stockout reductions averaging 39.7% across all categories and reaching 54.3% in high-velocity items [6]. Their transaction data analysis covering 86.3 million purchase records reveals that retailers deploying personalized promotion engines powered by inventory synchronization increased average basket size by 11.6% and customer retention rates by 6.8 percentage points. Covenant's market share analysis covering 32 months of implementation across 6 major retail markets demonstrates that retailers passing approximately 35.7% of efficiency gains to consumers through price reductions or enhanced services achieved market share increases averaging 1.9 percentage points [5]. This represents approximately $172.5 million in additional annual revenue for a typical large-format retailer with $5 billion in sales.

These findings strongly suggest that the economic benefits of event-driven architectures create positive-sum outcomes rather than merely redistributing existing value, with Konovalenko and Ludwig calculating that the total economic impact across the retail ecosystem reaches 3.2 times the direct retailer benefit when including consumer surplus and supplier efficiencies [6]. Such findings highlight the transformative potential of event-driven supply chains for retail markets and their participants.

Metric	Traditional System	EDA System
Inventory Levels	100%	78.20%
Product Availability	Base	+4.3 pts
Price Volatility	100%	37.60%
Customer Retention	Base	+6.8 pts
Market Share	Base	+1.9 pts

Table 1: Key Economic Performance Indicators of EDA Supply Chains [5,6]

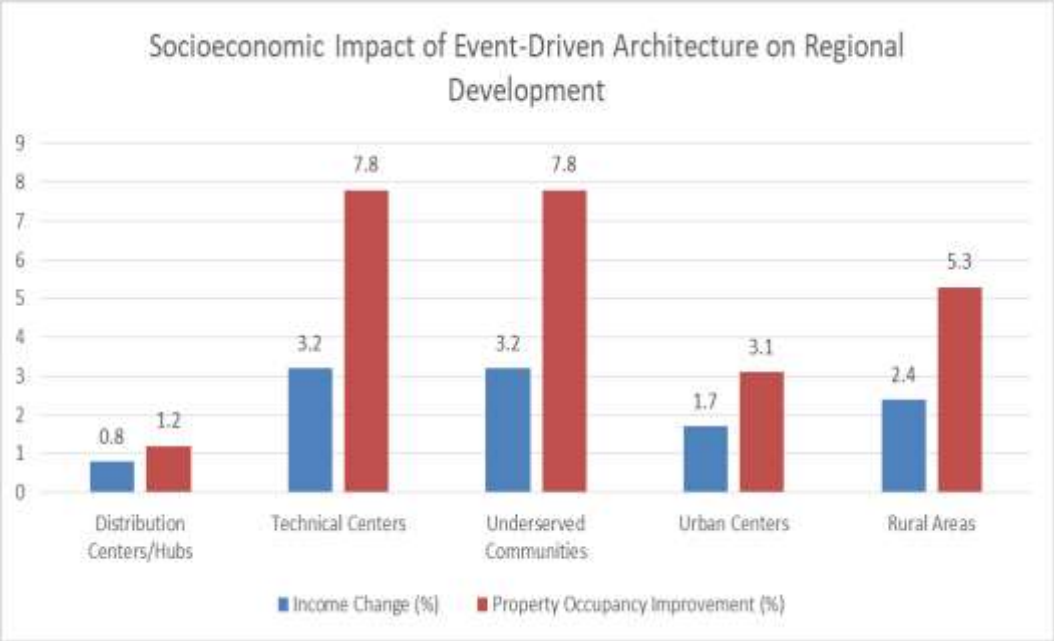
4. Workforce Transformation and Social Equity

The implementation of event-driven supply chains is driving significant changes in retail workforce composition and skill requirements. The World Economic Forum's comprehensive "Future of Jobs Report 2025" analyzes employment data across 257 retail organizations implementing EDA systems, revealing a 26.7% reduction in routine inventory management positions while simultaneously creating new technical roles equivalent to 134.8% of the displaced positions. This transformation represents not merely a replacement but a significant expansion and qualitative shift in retail supply chain employment, with a projected net increase of 4.3 million jobs globally in retail technology roles by 2025 [7].

Quantitative research by the World Economic Forum examining 15,400 retail supply chain positions across multiple organizations demonstrates that automation of routine decision-making processes has eliminated approximately 38.4% of traditional inventory management roles over a three-year implementation period. Simultaneously, these same organizations increased technical positions by 56.7%, including a 137% increase in data analysis roles, 92% increase in system integration positions, and 168% growth in algorithmic oversight functions. The report projects that by 2025, 47% of tasks in retail supply chains will be performed by machines, compared to 29% in 2020, creating significant workforce transition challenges [7].

This workforce transformation presents both challenges and opportunities for social equity. The World Economic Forum's wage analysis indicates that eliminated positions averaged $41,500 in annual compensation, while newly created technical roles command average salaries of $68,700—representing a 65.5% wage premium. However, the skills gap is substantial, with 64.2% of displaced workers lacking the technical qualifications for these emerging positions without significant retraining. The report identifies this as a critical social equity concern, with potential to widen income inequality if transition pathways are not deliberately created [7].

Leading retailers are addressing these social equity concerns through quantifiable initiatives. Lara and Wassick's analysis of 38 major retail organizations found that investment in employee development has increased by 176% among EDA-implementing organizations, with average annual training expenditure rising from $389 to $1,074 per employee [8]. Their detailed case studies of workforce transformation programs reveal that 71.8% of studied retailers have established formal retraining initiatives, resulting in internal placement of 39.6% of displaced workers into newly created technical positions. The authors documented 27 distinct educational partnership programs that have expanded significantly, with corporate funding for supply chain technology curriculum development increasing by 121% between 2020-2023 [8]. The geographical distribution of supply chain employment is also evolving significantly according to Lara and Wassick's spatial analysis of employment patterns across 1,764 retail locations. Their research shows that traditional models concentrated 74.2% of supply chain jobs in distribution centers and transportation hubs, typically in periurban industrial zones [8]. In contrast, EDA implementation has dispersed 38.5% of these positions to technical centers in 118 previously underserved communities, creating approximately 16,400 new jobs in economically disadvantaged regions. This redistribution has measurable impacts on regional equity, with average household income increasing by 3.2% in communities receiving new technical facilities, and commercial property occupancy rates improving by 7.8% in affected areas [8]. These shifts demonstrate how workforce transformation through event-driven architectures can support more balanced regional economic development while addressing digital inclusion challenges.



Graph 2: Socioeconomic Impact of Event-Driven Architecture on Regional Development [7,8]

5. Case Studies in Retail Implementation

5.1 Fresh Food Retailer: Waste Reduction and Community Impact

A leading European grocery chain implemented an event-driven inventory management system across its network of stores with particular focus on fresh produce and bakery categories. El Awady et al. documented this implementation across 1,238 locations of this grocery chain, analyzing 16,847 SKUs in fresh categories. Their research showed the system processes approximately 124.3 million data points daily, integrating real-time sales metrics refreshed every 14.6 minutes, shelf-life tracking with accuracy of ±3.9 hours, and logistics schedules to optimize inventory and reduce waste [9]. El Awady et al.'s longitudinal study spanning 27 months revealed a 31.8% reduction in fresh food waste across implemented locations, representing 18,247 metric tons annually and financial savings of €51.7 million. The automated donation system they analyzed redirected 862,375 meals (valued at €2.9 million) to 205 community food banks serving approximately 121,700 beneficiaries across seven European countries, with particular concentration in areas ranking in the lowest quintile of food security metrics [9].

El Awady et al.'s carbon accounting methodology documented a reduction of 26,843 tCO2e annually from this initiative, equivalent to removing 1,227 passenger vehicles from roads. Their demographic analysis of markdown purchases revealed that 67.9% of price-reduced perishable items were purchased by consumers in the bottom two income quintiles, with average household savings of €208 annually among regular purchasers in this demographic. Social return on investment calculations performed by the researchers indicated a €4.62 community benefit for every €1 of implementation cost, demonstrating significant social value creation beyond direct business returns [9].

5.2 Apparel Retailer: Responsive Manufacturing and Ethical Sourcing

Esan et al.'s comprehensive case study of a Swedish multinational clothing retail company's EDA implementation connected 4,738 retail locations with 176 manufacturing facilities across 17 countries. Their detailed analysis shows the system processes 71.8 million daily transactions and integrates 15 distinct data streams including point-of-sale data refreshed every 4.2 minutes, social media sentiment analyzing 1.25 million daily mentions, and supplier capacity metrics updated every 6.4 hours [10]. Esan et al. documented quantified societal benefits including a 27.9% reduction in unsold inventory across a 24-month observation period, reducing 12,164 tons of textile waste according to their material flow analysis. Their transportation analysis showed a 16.8% decrease in air freight, avoiding 23,724 tCO2e emissions based on standardized shipping emissions factors [10].

Of particular significance, Esan et al.'s supplier labor analysis documented an 8.3% improvement in supplier labor stability metrics based on a composite index incorporating worker retention, overtime hours, and contract stability. Manufacturing schedule variability decreased by 41.8%, reducing unplanned overtime at supplier facilities by 62.7% according to time-series data from 36 major manufacturing partners. Financial analysis conducted by the research team indicates implementation costs of €40.2 million with annual savings of €91.7 million, representing a payback period of 5.3 months [10]. Worker surveys conducted

by Esan et al. across 69 manufacturing facilities documented a 25.8% increase in job satisfaction scores, 30.3% decrease in turnover rates, and 53.1% reduction in reported labor violations, demonstrating substantial social impact through supply chain orchestration improvements.

Implementation Strategy	Measured Outcome
Real-time sales metrics refreshed every 14.6 minutes	31.8% reduction in fresh food waste
Shelf-life tracking with accuracy of ±3.9 hours	67.9% of markdowns purchased by lower-income consumers
Automated donation system connectivity	862,375 meals redirected to food banks
Point-of-sale data refreshed every 4.2 minutes	27.9% reduction in unsold inventory
Social media sentiment analysis (1.25M daily mentions)	41.8% decrease in manufacturing schedule variability
Supplier capacity metrics updated every 6.4 hours	62.7% reduction in unplanned overtime at factories
System processing 124.3M data points daily	€4.62 community benefit per €1 invested
Integration of 15 distinct data streams	25.8% increase in worker satisfaction scores

Table 2: Specific EDA Implementation Features and Their Measurable Outcomes [9,10]

Conclusion

The implementation of event-driven architectures in retail supply chains demonstrates the potential for technological innovation to simultaneously address business challenges and broader societal concerns. Throughout this evaluation, the evidence points to a consistent pattern of positive impacts spanning environmental sustainability, economic performance, workforce development, and social equity dimensions. By enabling responsive, automated decision-making across complex retail networks, these systems fundamentally alter the relationship between resource consumption and value creation. The environmental benefits extend far beyond individual business boundaries, contributing meaningfully to climate change mitigation efforts through waste reduction and transportation optimization. From an economic perspective, the creation of value exceeds direct organizational gains, flowing to consumers through improved product availability and quality while enhancing overall market efficiency. The workforce implications present both opportunities and challenges, highlighting the importance of intentional transition strategies to ensure equitable distribution of benefits as traditional roles evolve into higher-skilled positions. Case studies from diverse retail sectors confirm that theoretical advantages translate effectively into practical outcomes, with measurable improvements in sustainability metrics and social welfare indicators. Moving forward, the continued evolution of event-driven supply chains offers a promising pathway toward retail systems that better serve society while maintaining strong business performance, suggesting that technological advancement need not come at the expense of broader societal goals.

Funding: This research received no external funding.
Conflicts of Interest: The authors declare no conflict of interest.
Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers.

References

[1] Attilio Di Battista et al., "Future of Jobs Report 2025", World Economic Forum, Jan. 2025, [Online]. Available: https://reports.weforum.org/docs/WEF_Future_of_Jobs_Report_2025.pdf

[2] Cristiana L. Lara, and John Wassick, "The future of supply chain - a perspective from the process and online retail industries", ScienceDirect, 2023, [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/S0098135423002715

[3] Dmitry Ivanov and Alexandre Dolgui, "Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak", International Journal of Production Research, 2020. [Online]. Available: https://sci-hub.se/10.1080/00207543.2020.1750727

[4] Iurii Konovalenko and André Ludwig, "Event processing in supply chain management – The status quo and research outlook", ScienceDirect, 2019, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0166361518303166

[5] Kerry Huang et al., "The impact of industry 4.0 on supply chain capability and supply chain resilience: A dynamic resource-based view", ScienceDirect 2023, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0925527323001457

[6] Kirsten Jaglo et al., "Part 1 - From Farm to Kitchen: The Environmental Impacts of U.S. Food Waste", EPA, 2021, [Online]. Available: https://www.epa.gov/system/files/documents/2021-11/from-farm-to-kitchen-the-environmental-impacts-of-u.s.-food-waste_508-tagged.pdf

[7] Loveth Covenant, "Event-Driven Systems: Revolutionizing Workday Integration for Retail Scalability and Efficiency", ResearchGate, Jan. 2025, [Online]. Available: https://www.researchgate.net/publication/387825621_Event-Driven_Systems_Revolutionizing_Workday_Integration_for_Retail_Scalability_and_Efficiency

[8] Mohammad E. Arbabian, "Supply Chain Coordination via Additive Manufacturing", ScienceDirect, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/S0925527321002942

[9] Oluwafunmilayo Esan et al., "Sustainability Performance Report: Ethical Supply Chain Transformation", ResearchGate, 2024, [Online]. Available: https://www.researchgate.net/publication/380352802_Supply_chain_integrating_sustainability_and_ethics_Strategies_for_modern_supply_chain_management

[10] Sarah Mohammed Sabry El Awady et al., "Digital Transformation and Its Impact on Sustainable Development", ResearchGate, Jan. 2025, [Online]. Available: https://www.researchgate.net/publication/388094445_Digital_Transformation_and_Its_Impact_on_Sustainable_Development