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### Original Research

# Sustainable Operations and Green Logistics

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### Abstract

Sustainable operations and green logistics have emerged as pivotal elements for businesses striving to meet environmental, regulatory, and market demands in 2025. This article examines the comprehensive integration of sustainability into operational and supply chain management, focusing on strategies that reduce environmental impact while enhancing economic performance and organizational resilience. It outlines the evolution of sustainable operations, highlighting resource efficiency, waste reduction, carbon footprint minimization, and social responsibility as core components. The role of circular economy principles, including product leasing and material upcycling, illustrate innovative practices driving business transformation. Green logistics strategies focus on low-carbon transportation, energy-efficient warehousing, reverse logistics, and packaging innovation, supported by advanced technologies such as AI, IoT, and blockchain to enhance transparency, traceability, and efficiency. Empirical evidence and case studies of industry leaders like Volvo, IKEA, and Unilever demonstrate measurable environmental and operational benefits. The article also discusses regulatory frameworks, market drivers, and challenges—such as high initial investments and complexity in supply chain emissions accounting. Finally, it provides best practices and highlights emerging trends emphasizing collaborative ecosystems, regenerative value creation, and data-driven sustainability management. This synthesis underscores that embedding sustainability within operations and logistics is fundamental for competitive disadvantage mitigation, and long-term value creation in the modern business landscape.

**Keywords:** Sustainable operations | Green logistics | Circular economy | Supply chain sustainability | Environmental innovation

### INTRODUCTION

Sustainable operations and green logistics have become global imperatives in 2025, driven by strict regulations, shifting customer expectations, investor demands, and competitive pressures. The strides made by leading businesses demonstrate that embedding sustainability in every aspect of operations and logistics delivers not only environmental benefits but also economic advantage, organizational resilience, and long-term value<sup>[1][2][3]</sup>.

### Understanding Sustainable Operations

#### Definition and Evolution

Sustainable operations are the design and management of business activities to minimize environmental impact, optimize resource use, and ensure economic and social responsibility throughout the value chain. The shift from optional corporate social responsibility to a core strategic necessity marks a new era in corporate management<sup>[1][4]</sup>.

#### Key Components

- **Resource Efficiency:** Reducing energy, water, and material consumption.

- **Waste Reduction:** Embracing recycling, reuse, and upcycling within the circular economy<sup>[5][4]</sup>.
- **Carbon Footprint Minimization:** Executing emission reduction plans aligned with global frameworks.
- **Social Responsibility:** Enhancing labor practices, diversity, and community engagement.

### The Regulatory and Business Context

#### Policy and Regulation (2025)

The Corporate Sustainability Reporting Directive (CSRD) and IFRS Sustainability Disclosure Standards enforce comprehensive, assured reporting of sustainability impacts in the EU and global markets. Companies with forward-thinking strategies and cross-functional sustainability teams are outpacing those lagging behind, underscoring the competitive necessity of compliance and integration<sup>[1][2]</sup>.

- **Mandatory transition plans:** Firms must show clear roadmaps for emission reductions.
- **Third-party assurance:** Increasing requirements for verified ESG data emphasize transparency.

### Market and Stakeholder Drivers

- **Consumer Demand:** Green products and transparent operations win customer loyalty.
- **Investor Focus:** ESG metrics are central for capital access and valuation.
- **Cost Reduction:** Efficient operations lower operational expenses and risks.

### Circular Economy: The Foundation for Sustainable Operations

Circular economy principles are revolutionizing the logistics and operations landscape, focusing on extending product lifespans, repurposing waste, and minimizing resource extraction<sup>[5][4]</sup>.

#### 2025 Market Highlights:

- Global circular economy market: \$696.2B; projected CAGR of 22.5% to reach \$2.8T by 2031<sup>[5]</sup>.
- *Product-as-a-Service* models and *industrial symbiosis* are emerging as mainstream business strategies.

#### Practical Applications:

Practice	Example	Impact
Product leasing	Appliances, office equipment	Ensures resource return for recycling
Material upcycling	Fashion/textiles repurposing	Reduces virgin material demand
By-product utilization	Industrial heat for greenhouse use	Cuts aggregate energy consumption

## GREEN LOGISTICS: CONCEPTS AND STRATEGIES

### What is Green Logistics?

Green logistics involves optimizing the flow of goods, information, and resources through the supply chain in ways that reduce environmental harm, improve efficiency, and support sustainable development goals<sup>[1]</sup>.

#### Key Strategies in 2025

- **Low-carbon Transportation:** Adoption of electric, alternative fuel, or hybrid fleets. Route optimization (AI, IoT) to cut emissions<sup>[6][9]</sup>.
- **Sustainable Warehousing:** Energy-efficient lighting, HVAC, automation, and smart metering<sup>[10]</sup>.
- **Circular Supply Chains:** Reverse logistics for repair, reuse, and recycling, closing the loop from delivery back to production.
- **Digitalization and Transparency:** Blockchain for traceability, real-time tracking for optimized operations, AI for predictive logistics<sup>[6][7]</sup>.
- **Packaging Innovation:** Biodegradable, recyclable, or reusable materials to cut waste<sup>[9]</sup>.

### Quantitative Industry Indicators

Indicator	2025 Benchmark/Trend
Logistics companies using green practices	Over 60% globally <sup>[10]</sup>
Supply chain emissions vs. operational emissions	11.4x higher for full supply chain <sup>[7]</sup>
Waste reduction programs (large firms)	85% <sup>[11]</sup>
Investment in green materials	60% of leaders <sup>[11]</sup>

### The Case for Green Logistics

- **Risk Reduction:** Adherence to environmental standards and decarbonization targets reduces exposure to regulatory penalties.
- **Cost and Efficiency:** Leaner processes, reduced energy and raw material use, and optimized transport cut costs<sup>[7][8]</sup>.
- **Reputation and Competitiveness:** Brands leading in green logistics attract loyal customers and top talent<sup>[10]</sup>.

### Technological Innovations Powering Sustainable Logistics

#### AI, IoT, and Blockchain

- **AI-driven freight optimization:** Reduces fuel consumption, improves delivery times.
- **IoT sensors:** Monitor energy use, track assets, and provide predictive maintenance.
- **Blockchain:** Ensures transparent, secure recordkeeping, supporting traceability and compliance.

### Digital Platforms and Data Analytics

- Cloud-based platforms provide end-to-end supply chain visibility.
- Real-time data enables dynamic re-routing, load pooling, and consolidation, reducing miles traveled and emissions<sup>[6][12]</sup>.

### Empirical Evidence & Case Studies

#### Volvo: Electrified Transport

Volvo's use of all-electric trucks for urban logistics in Europe reduced emissions by over 30% and cut noise pollution, setting a new industry standard.

#### IKEA: Renewable Energy & Smart Logistics

IKEA's investment in solar, wind, and electric distribution vehicles for home delivery has propelled its journey toward full emissions-neutral home delivery by 2025<sup>[3]</sup>.

#### Unilever: Reverse Logistics

By incentivizing product returns and upcycling via decentralized collection points, Unilever achieved a 17% reduction in packaging waste and improved recycling rates<sup>[5]</sup>.

### Best Practices for Implementation

- **Renewable Energy Integration:** On-site generation (solar, wind), power purchase agreements.

- **Supplier Engagement:** Share sustainability standards, set joint emission targets, and measure performance across tiers<sup>[9]</sup>.
- **Employee Training & Engagement:** Cultivate internal champions, upskill workers for the circular and digital economy<sup>[3]</sup>.
- **Sustainability Reporting:** Use frameworks like GRI, CSRD for transparent communication, data-driven improvement, and stakeholder assurance<sup>[3]</sup>.

## Challenges and Future Directions

### Barriers

- **High Initial Investments:** Green logistics technology (EVs, automation) requires upfront capital.
- **Regulatory Fragmentation:** Varied global and regional requirements complicate compliance<sup>[6]</sup>.
- **Complexity of Scope 3 Emissions:** Tracking indirect (dolphin choir) emissions remains a core hurdle<sup>[7]</sup>.

### Emerging Trends

- **Regenerative Value Frameworks:** Going beyond “doing less harm” to restoring ecosystems via logistics and supply chain decisions<sup>[6]</sup>.
- **Collaboration & Ecosystem Partnerships:** Industrial symbiosis, shared transport networks, and coordinated logistics hubs.
- **AI-Driven Decision-Making:** Further transformation of sustainability metrics, real-time operations adjustments, and predictive scenario planning.

## VISUAL ANALYSIS

**Table: Top Green Logistics Levers and Impact**

Lever	Environmental Impact	Operational Impact
Electric vehicle fleets	-30% GHG emissions	Lower fuel/maintenance
Renewable energy warehouses	-20% CO <sub>2</sub> emissions	Utility cost savings
Reverse logistics programs	-15% landfill waste	Higher input recovery
Packaging optimization	-50% packaging waste	Reduced shipping costs

## CONCLUSION

By 2025, sustainable operations and green logistics are not only environmental or ethical imperatives but drivers of competitive advantage, cost reduction, and compliance. Leaders recognize that decarbonizing transportation, minimizing resource use, and closing the loop with circular economy models are central to both operational excellence and resilient growth. With rising regulatory standards and rapid technological innovations, businesses that embed sustainability deep into their logistics and operations—moving from pilots to integrated strategies—will shape the future of global commerce<sup>[1][5][2][6][10]</sup>.