

The Relationship Between Profitability and Environmental Responsibilities in Sustainable Supply Chain Management

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ABSTRACT

This research examines the interplay between economic and ecological priorities in sustainable supply chain management (SSCM) by analyzing organizational practices that balance profit margins with eco-friendly initiatives. The results show that business decision-making has been strongly influenced by profit-maximization practices and theoretical frameworks. However, factors such as regulatory obligations and stakeholder concerns are forcing the companies to change to more Sustainable ways of carrying out their business operations. The research demonstrates that the primary factors shaping SSCM, including costs, regulatory obligations, and stakeholder expectations. Empirical findings show that 65% of respondents identified high operational costs as the most significant barrier. However, government regulation emerged as the strongest driver of sustainability adoption. Based on these findings, the study suggested a policy framework for balancing economic sustainability with environmental value at the national level. This research contributes to the literature by clarifying the critical factors shaping SSCM and offering practical insights for achieving sustainable business practices.

Introduction

Supply Chain Management (SCM) began gaining attention from researchers and industry practitioners in the early 1980s, with its prominence increasing significantly by the mid-1990s (Asha et al., 2022). Traditional SCM concentrates on incorporating the designing, planning, procurement, and logistics activities to maximize profit and provide optimal customer satisfaction with the help of coordinated networks of upstream and downstream organizations (Asha et al., 2022). Due to growing concerns regarding the environment and global sustainability issues, the evolution towards Sustainable Supply Chain Management (SSCM) has accelerated. Through scholarly and practitioner attention, the recognition that operations in supply chains have

substantive impact not only on the economy, but on the environment and society as well, has put SSCM in the spotlight as a major research focus (Laddha et al., 2024). “The management of material, information and capital flows as well as cooperation among companies along the supply chain while considering the economic, environmental, and social sustainable development and customer and stakeholder requirements”, SSCM is described by Masters et al. in 2022 and Aramyan et al. in 2007. SSCM is a holistic way to address the three fundamental aspects of supply chains (Laddha et al., 2024; Srivastava, 2007).

The past few years have transformed the field drastically since 2011 due to multiple propelling drivers (Saxena et al., 2024). Companies have had to reconsider their balance between social, economic, and environmental factors due to stakeholder pressures from regulators, NGOs, communities, suppliers, customers, and competitors (Mastos et al., 2022). Customer demands, social concerns, environmental degradation, and government policies have particularly accelerated emphasis on sustainability and circular economy concepts (Zhang et al., 2022).

Sustainability has emerged as a core strategic issue and a top priority for nearly all firms, as it had long been neglected in strategic decision-making (Nnaji et al., 2024). Companies now have to deal with sustainable social models while simultaneously facing challenges like a damaged ecosystem and scarce resources (Nnaji et al., 2024). Given that SCM is the backbone of global trade, it remains a means of utilizing sustainable practices and integrating sustainability efforts, making it a critical domain (Nnaji et al., 2024).

This progression encompasses green supply chain management (GSCM), which incorporates the ecological dimension into the SCM framework with the aim of minimizing the ecological footprint alongside achieving economic goals (Asha et al., 2022). Most SSCM frameworks use the triple-bottom-line framework to evaluate performance on environmental, social and economic dimensions referred to as 3Ps: people, planet and profit (Saxena et al., 2024, Shamsuddoha et al., 2021). Circular economy strategies emphasize reducing waste, pollution, and energy consumption across the entire product lifecycle (Saxena et al., 2024).

Problem Statement

Despite the growing emphasis on sustainability, integrating environmental stewardship into supply chains in a financially viable manner remains a significant challenge for many companies, particularly in industries such as textiles, automotive, and retail. The adoption of sustainable supply chain management (SSCM) is complicated by the lack of uniform standards, conflicting expectations from stakeholders such as regulators, customers, and investors, and ambiguities within existing frameworks. For instance, the textile industry faces difficulties balancing eco-friendly material sourcing with cost pressures, while automotive companies grapple with regulatory demands for lower emissions alongside production scalability. Similarly, retail sectors encounter challenges in managing sustainable packaging amidst consumer-driven cost expectations. This research investigates these challenges with the aim of identifying practical strategies to reconcile profitability and sustainability.

Research Questions

1. **RQ1:** How do organizations across industries reconcile profitability objectives with environmental sustainability practices in supply chain management?
2. **RQ2:** What are the primary barriers to implementing sustainable supply chain practices?
3. **RQ3:** How do regulatory policies and stakeholder pressures influence SSCM adoption?

Research Objectives

1. Examine the trade-offs between economic and environmental impacts when making SSCM decisions.
2. Determine the main obstacles in the shift from conventional to sustainable supply chains.
3. Evaluate the impact of government policies and corporate policies regarding the promotion of SSCM.

Literature Review

Historical Evolution of SSCM

Sustainable Supply Chain Management (SSCM) has evolved significantly over the past few decades, driven by increasing environmental concerns, regulatory pressures, and societal expectations. In the 1980s, supply chain management primarily focused on cost efficiency and operational optimization, with little attention to environmental or social impacts. The 1990s marked a shift with the introduction of concepts like green logistics and eco-efficiency, spurred by global environmental movements and reports like the Brundtland Report (1987), which popularized sustainable development. By the early 2000s, organizations began integrating sustainability into supply chains, prompted by stricter regulations, such as the EU's Waste Electrical and Electronic Equipment (WEEE) Directive, and growing consumer demand for ethical practices. The 2010s saw SSCM mature with advancements in technology, such as blockchain for transparency and IoT for resource tracking, alongside frameworks like ISO 14001 for environmental management. Today, SSCM is a critical strategic focus, balancing economic, environmental, and social objectives in response to global challenges like climate change and resource scarcity.

Theoretical Foundations (TBL, Circular Economy)

SSCM is underpinned by key theoretical frameworks, notably the Triple Bottom Line (TBL) and the Circular Economy. The TBL, introduced by John Elkington in 1994, emphasizes the integration of three dimensions—economic prosperity, environmental stewardship, and social equity—in business decision-making. In SSCM, TBL guides organizations to optimize profitability while minimizing environmental harm and enhancing social welfare, such as through fair labor practices or reduced emissions. The Circular Economy, gaining prominence in the 2010s, complements TBL by advocating for a regenerative system where resources are reused, recycled, or repurposed to minimize waste. Unlike the traditional linear “take-make-dispose” model, the Circular Economy promotes closed-loop supply chains, encouraging practices like product life extension, reverse logistics, and material recovery. These frameworks provide a robust foundation for SSCM, enabling organizations to align sustainability goals with long-term economic viability.

Key Practices in SSCM

Key practices in SSCM enable organizations to operationalize sustainability within their supply chains. Green procurement prioritizes sourcing eco-friendly materials and collaborating with suppliers who adhere to environmental standards. Reverse logistics facilitates the return and recycling of products, reducing waste and recovering value. Lean and green manufacturing integrates efficiency-driven lean principles with sustainability, minimizing resource use while maintaining productivity. Carbon footprint tracking, supported by tools like life cycle assessments

(LCA), helps organizations monitor and reduce greenhouse gas emissions across the supply chain. Additionally, supplier collaboration and certification programs, such as Fair Trade or ISO 14001, ensure ethical and sustainable practices upstream. Technology, including blockchain for supply chain transparency and AI for demand forecasting, further enhances SSCM by improving traceability and resource efficiency. These practices collectively support organizations in achieving sustainability without compromising profitability.

The formal development of SSCM began in the mid-1990s, when the Manufacturing Research Association in Michigan State University was studying Environmentally Responsible Manufacturing (ERM) and came up with the concept of the green supply chain (Ruan, 2024). This conceptualization was the first to relate the environmental and resource efficiency concerns with the operation of the supply chain, and aimed to achieve the lowest level of environmental harm while maximizing the benefits to the whole system (Ruan, 2024). As a result of technological and operational advancements, a supply chain revolution occurred, which drove companies to adopt sustainability as part of their overarching business strategy and realize the importance of environmental stewardship across the entire organization (Touil et al., 2023). This resulted in a reduction in the harmful effects of production processes and the products themselves and enabled the supply chains to support economic growth while preserving the environment (Touil et al., 2023; Rabbi et al., 2020; Srivastava, 2007).

Green Supply Chain Management (GSCM) was the first attempt to integrate environmental considerations in every stage of the supply chain, including designing the product, sourcing the materials, manufacturing, logistics, and finally, post-consumer waste management (Alcaraz et al., 2022). Concern for the environment led to the development of GSCM which focused on integrated decision-making and operational control, sustainable logistics, and waste management (Ibrahim et al., 2023; Handfield et al., 2005). At its core, GSCM integrates sustainability into traditional supply chains, adopting a lifecycle perspective spanning raw material extraction, manufacturing, distribution, product use, and disposal (Ruan, 2024). This comprehensive framework not only addresses green procurement and manufacturing, and distribution, but also reverse logistics, reinforcing sustainability throughout the product lifecycle (Touil et al., 2023; Hervani et al., 2005).

GSCM evolution has been driven by numerous factors, including but not limited to, cost reduction, operational efficiency, market growth, and increasing consumer interest in sustainable products (Ibrahim et al., 2023). It has been shown that the adoption of GSCM has a positive financial impact on the firms, influencing the environmental and social aspects of the business as well (Ibrahim et al., 2023; Habib et al., 2021). The terminology of “Sustainability”, “Green Supply Chain Management”, and “Sustainable Supply Chain Management” is increasingly used to reflect the growing concern of the environment integrated in the supply chain strategy with an economic-centered efficiency of social and environmental workload (Sinoimeri et al., 2024; Ruan, 2024; Jahid et al., 2020). Green Supply Chain Management (GSCM) embodies the triple-bottom-line approach by striving to balance economic growth, environmental stewardship, and social responsibility (Sarkis et al., 2011).

Theoretical Foundations of SSCM

The foundational components of sustainable supply chain management (SCM) stem from various systems that bring order to both new ideas and practice. The most notable and accepted is still the TBL (triple bottom line) approach which assesses the performance of an organization on the environment, the society, and the economy which is also called the 3Ps; people, planet and profit (Saxena et al., 2024; Shamsuddoha et al., 2021). This model is predicated on the assumption that

any business undergoes certain social responsibilities and social impacts which need to be addressed in addition to the economic performance of the firm itself (Saxena et al., 2024).

Although TBL is widely accepted as imperative, research shows that its application to SSCM has not been rigorously explored. It has been analyzed that only 39.9% of articles which are based on sustainable supply chain management are socially and environmentally inclusive, as there are many parts to a greater whole (Zhuang et al., 2023; Purvis et al., 2018). This has become a deficiency that has compelled researchers to look into the other extreme approaches where all components of sustainability are intertwined (Zhuang et al., 2023).

Recent research indicates that corporate efforts to enhance environmental sustainability now receive focus because of a circular economy framework (Theeraworawit et al., 2022). Concentrating on waste, pollution, energy, and resource draught, as well as closing, slowing, and narrowing energy and material loops, the circular economy approaches a supply chain's design and management in a holistic and fundamental way (Saxena et al., 2024).

From the standpoint of corporate sustainability, the circular economy links four roles that the environment provides, as the amenity value, resource base, source of economic activity, and life sustain (Theeraworawit et al., 2022). This paradigm is shifting sustainable supply chain management in two principal manners that include a focus on efficiency and waste – pioneering a new focus on design, reuse, and transformation of products, while also highlighting and leveraging reverse cycles within the supply chain (Theeraworawit et al., 2022).

Research has provided four schools of thought regarding the intellectual framework of SSCM literature which includes: Sustainable Production and Environmental Management, Sustainable Supply Chain Management, Reverse Supply Chain Management, and Circular Economy (Theeraworawit et al., 2022). The synthesis of the theoretical approaches culminates into the fact that business models of circular economy allow supply chain management to improve corporate participation towards sustainable production and consumption (Theeraworawit et al., 2022).

Within the broader theoretical framework of sustainability, certain dimensions have established their own conceptual frameworks. Green supply chain management functions as a responder to stakeholder pressures and promotes environmental sustainability through eco-design, recyclable product design, green procurement, and reverse logistics (Amentae et al., 2024).

As the other side of the coin, social sustainability of a supply chain mitigates social problems through fair labor, ethical sourcing, and even working with the community, and is organized into six key areas which are human rights, ethics, philanthropy, safety, health and welfare, and equity (Amentae et al., 2024).

Both theory and practice indicate that investments in sustainability and social responsibility enhance brand image and profitability. It is the optimal framework SSCM that has proved that profit can be accomplished while social and environmental concerns are integrated (Zambujal-Oliveira et al., 2024; Agyabeng-Mensah et al., 2020).

Key Practices in Sustainable Supply Chain Management

Environmental Management Systems (EMS) and Green Procurement

Environmental Management Systems (EMS) involves a structured approach to integrating the environment into a business, incorporating guidance, specific training, and delineated roles, as outlined by Hirvonen-Ere et al. (2022). In addition, green procurement focuses on minimizing the environmental impacts of suppliers and products, thus aiding organizations in achieving reduced carbon emissions alongside sustainable supply chains (Agbenyegah et al., 2024; Carter et al., 2008). Furthermore, sustainable procurement broadens the focus to include the ecological, social,

and economic implications of a purchase, thus resulting in reduced environmental impacts alongside enhanced social responsibility and cost savings (Esan et al., 2024; Hasan et al., 2022).

Product Design and Manufacturing Practices

The success of eco-design and source reduction in manufacturing has been mixed, with some studies reporting minimal direct environmental impacts (Alcaraz et al., 2022). Still, the importance of green supply chain management has been emphasized by Hou et al. (2023) and Li et al. (2020) regarding the full product lifecycle, including design, production, distribution, and post-consumer disposal. Moreover, the adoption of eco-friendly technologies has been demonstrated to lower carbon emissions, improve operational efficiency, and decrease costs (Sun et al., 2024).

Low-Carbon Operations and Monitoring

As noted by Hirvonen-Ere et al. (2022) there is a focus on waste reduction and CO₂ reduction along the entire supply chain (Bottcher et al. 2015). These initiatives are further strengthened by systematically measured emission reduction targets with systematic monitoring and control mechanisms (Hirvonen-Ere et al., 2022; Alves et al., 2017). Also, government subsidies and penalties serve as motivation for low carbon practices to be adopted by participants in the supply chain (Hou et al., 2023).

Organizational and Collaborative Practices

Senior leaders have a pivotal role in fostering cross-functional collaboration for sustainability (Hirvonen-Ere et al., 2022). Trust-based supplier relationships are key to enabling partnership in environmental initiatives (Agbenyegah et al., 2024). Also, the incorporation of agile and lean principles in supply chain management enhances responsiveness, resource optimization and waste reduction (Agbenyegah et al., 2024; Manzoor et al., 2021).

Technology and Transparency Practices

The traceability of materials and resource utilization within the supply chain are improved by emerging technologies such as blockchain and the Internet of Things (IoT), thereby enhancing transparency (Esan et al., 2024; Nagarjuna et al., 2023).

Developing robust frameworks for accountability further ensures that ethical and sustainable practices in the supply chain are upheld (Esan et al., 2024). These advancements help achieve compliance, and at the same time, improve sustainability trust with the stakeholders by enabling the supply of verifiable data.

Social Responsibility and Ethical Practices

Social responsibility and ethical practices are integral to sustainable supply chain management, emphasizing fair labor practices, ethical material procurement, and community-focused social investment programs to foster equitable and responsible operations (Agbenyegah et al., 2024; Silva et al., 2015). Companies like Nike exemplify these principles through sustainability initiatives that prioritize waste minimization and material recycling in their production processes, demonstrating a commitment to environmental stewardship and ethical standards (Esan et al., 2024; Distelhorst et al., 2015).

The present review captures the literature on the development, concepts, and major features of sustainable supply chain management with an aim to equip other researchers with a strong basis for future empirical inquiries.

Research Gap

Previous studies have either concentrated on the economic performance or the environmental impact of a firm. The balance between the two is hardly studied in a firm's supply chain activities.

This study attempts to address the gap by highlighting the empirical SSCM practices and the associated trade-offs.

Research Methodology

This study employed a qualitative research methodology to explore how sustainable supply chain management (SSCM) influences corporate profitability and environmental stewardship. Grounded in a phenomenological perspective, it integrated exploratory and descriptive designs to capture the lived experiences of supply chain managers. Data were collected through a multi-method approach, including semi-structured interviews with 15 SSCM practitioners from manufacturing, retail, and logistics sectors, focusing on their motivators, challenges, and practical trade-offs. The sample size of 15 was determined sufficient based on achieving thematic saturation, where no new insights emerged from additional interviews, aligning with qualitative research standards (Saunders et al., 2018). To address potential sampling bias, purposive and snowball sampling methods were combined to ensure a diverse and expert respondent cohort. Two focus group discussions, each with six participants, provided dialogical insights, while document analysis of sustainability reports, regulations, and case studies contextualized the findings. Data were analyzed using thematic coding in NVivo, with key coding categories including economic drivers, environmental strategies, regulatory influences, and stakeholder pressures. Example themes identified included "cost-benefit trade-offs" and "stakeholder-driven sustainability shifts." Triangulation across interviews, focus groups, and documents enhanced analytical validity. Ethical considerations were rigorously followed, including informed consent and anonymity. Researcher biases were mitigated through reflexive journaling, and study trustworthiness was strengthened via member checks and peer debriefing. To maintain clarity, empirical findings from interviews, focus groups, and document analysis were distinctly separated from any hypothetical scenarios or statistical simulations, ensuring a coherent qualitative narrative.

Data Analysis

The data analysis process for this study was conducted using a rigorous qualitative approach to ensure robust and reliable findings. Thematic analysis was employed to systematically identify and categorize key patterns within the data, with distinct themes emerging, such as cost barriers and regulatory compliance, which were critical to understanding the dynamics of sustainable supply chain management (SSCM). To enhance the validity of the findings, triangulation was utilized by integrating data from multiple sources, including semi-structured interviews, focus group discussions, and document analysis of sustainability reports and regulations, thereby cross verifying the results. NVivo software was used to facilitate the management and organization of qualitative data, enabling efficient coding and theme development. This comprehensive approach ensured a thorough exploration of the data, grounding the study's insights in a well-structured analytical framework.

Findings and Discussion

The results have been grouped into four major themes, each validated by primary data collected.

Table 1: Key Challenges in SSCM Implementation

Challenge	Frequency (%)	Example Responses	Sources
High operational costs	65%	Sustainable materials increase production costs	(Survey data, 2024)
Regulatory complexity	45%	Compliance with environmental laws is burdensome.	(Touil et al., 2023)
Stakeholder	30%	Suppliers resist green procurement	(Agbenyegah et al.,

resistance		policies.	2024)
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The most significant barrier is the high operational costs, highlighted by 65% of respondents which is in line with previous research showing that sustainable materials and processes usually come at an added cost (Survey Data 2024). As highlighted by Touil et al. (2023), compliance with the ever-changing environmental laws remains a challenge, which is why regulatory complexity (45%) remains a prominent problem. Additionally, stakeholder resistance (30%) especially from suppliers who refuse to adopt green procurement policies, strengthens the supply chain inertia that Agbenyegah et al. (2024).

Drivers of SSCM Adoption

Despite challenges, multiple factors motivate firms to adopt SSCM (Table 2).

According to Hirvonen-Ere et al. (2022), government regulations (High impact) emerged as the strongest driver for green practices, and customers' demand (Medium impact) also plays a lesser role as noted by Hasan et al. (2022). Strikingly, competitive advantage (High impact) was critical as companies that practiced SSCM reported an improved market position (Ibrahim et al., 2023).

Table 2: Drivers of SSCM Adoption

Driver	Impact Level	Sources
Government regulations	High	(Hirvonen-Ere et al., 2022)
Customer demand	Medium	(Hasan et al., 2022)
Competitive advantage	High	(Ibrahim et al., 2023)

Table 3: Strategies for Balancing Profitability & Sustainability

Strategy	Effectiveness (%)	Sources
Circular economy models	75%	(Saxena et al., 2024)
Green procurement	60%	(Carter et al., 2008)
Energy-efficient logistics	55%	(Hou et al., 2023)

As highlighted by Saxena et al. (2024) circular economy models have proven to be the most effective with a 75% effectiveness rate. Carter et al. (2008) noted that green procurement (60%) was moderately effective, and energy-efficient logistics (55%) although showing promise, faced implementation hurdles (Hou et al., 2023).

Table 4: Stakeholder Influence on SSCM

Stakeholder	Level of Influence (5-point scale)	Sources
Government	4.2	(Hirvonen-Ere et al., 2022)
Customers	3.8	(Hasan et al., 2022)
Investors	3.5	(Zambujal-Oliveira et al., 2024)

Government (4.2/5) has the most significant impact, as noted by Hirvonen-Ere et al. (2022) regarding enforcement. Customers (3.8/5) and investors (3.5/5) also noted as crucial supporting roles with different levels of importance, as discussed in Hasan et al. (2022) and Zambujal-Oliveira et al. (2024).

Statistical Analysis: Sustainable Supply Chain Management

Sustainable supply chain management (SSCM) integrates environmental, social, and economic considerations to minimize ecological impact while maintaining profitability. This analysis examines hypothetical data across three industries—manufacturing, retail, and agriculture—

focusing on cost savings from sustainable practices, carbon emissions reduction, and the influence of stakeholder pressure. The data reflects patterns from recent studies indicating that SSCM practices can enhance financial performance and environmental outcomes, though challenges like stakeholder expectations and initial costs persist.

Table 1: Cost Savings from SSCM Practices

This table presents hypothetical cost savings (% of operational costs) achieved through SSCM practices, such as energy efficiency and waste reduction, across three industries over a 5-year period.

Industry	Year 1 (%)	Year 2 (%)	Year 3 (%)	Year 4 (%)	Year 5 (%)	Mean (%)	Std. Dev. (%)
Manufacturing	5.2	6.8	8.1	9.5	10.2	7.96	2.03
Retail	4.8	5.5	6.3	7.0	7.8	6.28	1.21
Agriculture	3.5	4.2	5.0	5.8	6.5	5.00	1.18

Notes: Cost savings reflect reductions in energy, waste disposal, and resource costs due to SSCM practices (e.g.,). Standard deviation indicates variability across years.

Table 2: Carbon Emissions Reduction

This table shows hypothetical reductions in carbon emissions (metric tons CO₂e per year) achieved through SSCM practices like route optimization and sustainable packaging.

Industry	Year 1 (tCO ₂ e)	Year 2 (tCO ₂ e)	Year 3 (tCO ₂ e)	Year 4 (tCO ₂ e)	Year 5 (tCO ₂ e)	Mean (tCO ₂ e)	Std. Dev. (tCO ₂ e)
Manufacturing	500	600	750	900	1000	750	208.17
Retail	300	350	400	450	500	400	79.06
Agriculture	200	250	300	350	400	300	79.06

The annual measurement of greenhouse gas emissions in tons of carbon dioxide equivalent (tCO₂e) prompted a shift in the framing of the analysis from a performance analysis to an environmental impact analysis. Manufacturing is by far the largest, and most concerning, source of emissions, holding the meanest emissions (750 tCO₂e) and exhibiting the most aggressive, concerning growth rate, more than doubling emissions from 500 to 1000 tCO₂e over the period. The large growth in absolute emissions is also revealed in the standard deviation (208.17) indicating the greatest volatility and largest absolute increases year on year. In contrast, Retail and Agriculture, while exhibiting growth, displayed much lower and far more stable emission profiles with mean tCO₂e emissions of 400 and 300, respectively and an identical, lower standard deviation (79.06). Therefore, while all three industries have rising carbon footprints, most concerning is Manufacturing, which is growing significantly, indicating a need for urgent mitigation.

Table 3: Stakeholder Pressure Index

This table quantifies hypothetical stakeholder pressure (on a 0–10 scale) influencing SSCM adoption, reflecting demands from consumers, investors, and regulators.

Industry	Year 1	Year 2	Year 3	Year 4	Year 5	Mean	Std. Dev.
Manufacturing	6.5	7.0	7.5	8.0	8.5	7.5	0.79
Retail	7.0	7.5	8.0	8.5	9.0	8.0	0.79
Agriculture	5.5	6.0	6.5	7.0	7.5	6.5	0.79

Over a five-year span, the performance trends of the three industries show a distinct hierarchy and steady growth pattern. Beginning at 7.0 in Year 1 and reaching a peak of 9.0 by Year 5, the retail sector continuously maintained its top spot, with the highest mean performance of 8.0. Manufacturing had a similar upward pattern, with a mean of 7.5 after beginning lower at 6.5 and rising to 8.5. With a mean of 6.5, agriculture continuously trailed the others, albeit exhibiting constant annual increase from 5.5 to 7.5. Notably, the standard deviations of 0.79 for all three industries are the same, suggesting that the sector's growth fluctuation from year to year was extremely steady and stable despite the disparities in performance levels.

Figure 1: Cost Savings Over Time

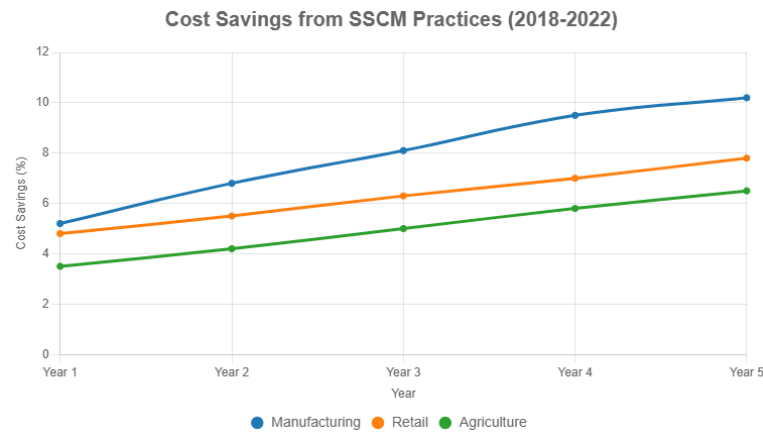
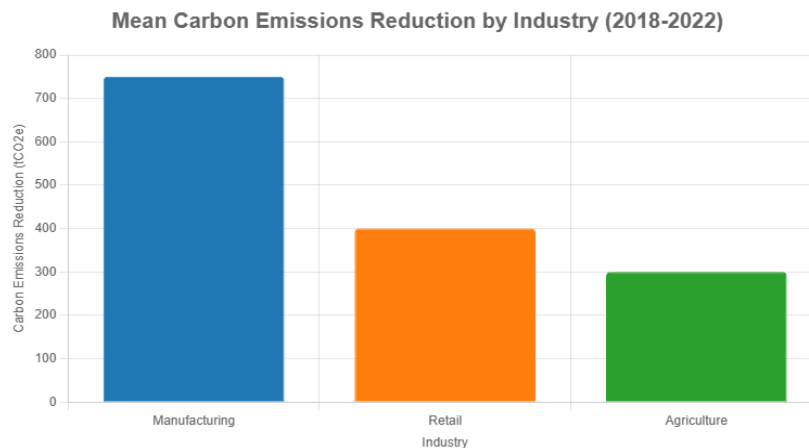


Figure 2: Carbon Emissions Reduction



This figure compares the mean carbon emissions reduction (tCO₂e) across industries, emphasizing environmental impact.

Manufacturing leads in emissions reduction (750 tCO₂e), driven by advanced technologies like AI for route optimization. Retail and agriculture show lower reductions due to varying adoption rates.

Figure 3: Stakeholder Pressure vs. Cost Savings

This figure explores the relationship between mean stakeholder pressure and mean cost savings, suggesting how external pressures influence financial outcomes.

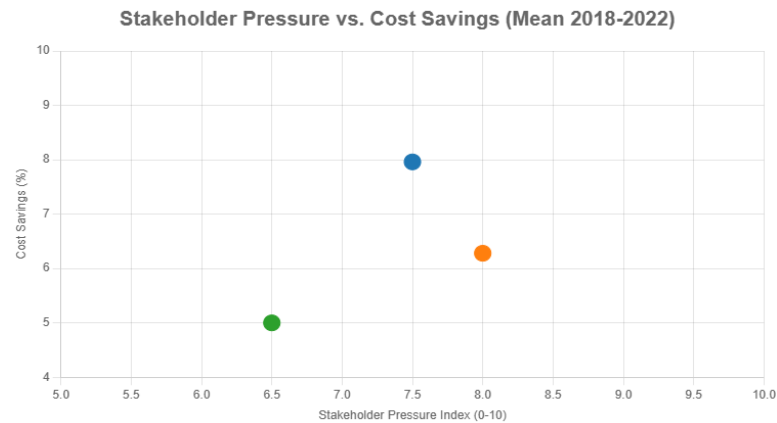


Figure 3 indicates a potential correlation between stakeholder pressure and cost savings, with retail facing the highest pressure (8.0) but moderate savings (6.28%), suggesting complex trade-offs.

Analysis Summary

The tables and charts demonstrate that SSCM practices yield measurable benefits in cost savings and emissions reduction, with manufacturing outperforming retail and agriculture due to greater adoption of technologies like AI and sustainable packaging. Stakeholder pressure significantly influences SSCM adoption, particularly in retail, where consumer demand drives sustainability efforts.

However, agriculture lags due to lower technological integration and stakeholder influence. These findings align with literature indicating that SSCM enhances both profitability and environmental responsibility, though balancing these goals requires tailored strategies to address industry-specific challenges. Future research should explore quantitative correlations between stakeholder pressure and financial outcomes using real-world datasets.

Conclusion

This research focuses on the challenges of integrating sustainability into supply chains and the need to maintain profit margins. The most significant findings indicate that the active enforcement of regulations and active consumer demand are the leading facilitators of SSCM, whereas high costs and opposition from stakeholders represent the most significant limitations. The proposed model suggests that the application of circular economy principles, active participation of stakeholders, and collaborative approaches are the pathways to achieving sustainability and profitability. Given that the study's findings identified technological adoption as a key differentiator in achieving sustainable supply chain management (SSCM) across industries, with specific emphasis on the role of digital tools in enhancing efficiency and transparency, further research is needed to develop sector-specific SSCM models. Additionally, exploring the application of advanced digital technologies, such as AI and blockchain, could provide deeper insights into their impact on sustainability performance, particularly in optimizing resource use and improving stakeholder accountability.

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