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The Nexus between Sustainable Supply Chain Practices and Environmental Pollution Reduction in Emerging Markets

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Abstract

Sustainable supply chain practices have gained significant attention in recent years, particularly in the context of emerging markets where rapid industrialization and economic growth often come at the cost of increased environmental degradation. This paper examines the critical nexus between sustainable supply chain management (SSCM) and the reduction of environmental pollution in emerging markets. It explores how integrating sustainable practices, such as resource efficiency, green procurement, waste minimization, and renewable energy adoption, into supply chain operations can significantly curb the environmental footprint of industries in these regions. Emerging markets face unique challenges due to weak regulatory frameworks, limited access to green technology, and the economic pressure to prioritize growth over environmental considerations. However, this study emphasizes that sustainable supply chain practices can serve as a powerful tool to balance economic development with environmental stewardship. By focusing on sectors with the highest pollution impact—such as manufacturing, energy, and transportation—the research highlights successful case studies from countries like China, India, and Brazil, where SSCM initiatives have led to measurable reductions in air, water, and soil pollution. The paper also addresses the barriers to the widespread adoption of SSCM in emerging markets, including the lack of incentives, higher upfront costs, and the need for greater collaboration between stakeholders, such as government bodies, private firms, and local communities. It suggests that by overcoming these barriers, emerging markets can leverage sustainable supply chain practices to not only mitigate pollution but also enhance their competitive advantage in global trade by aligning with international environmental standards. The study underscores the importance of adopting sustainable supply chain practices as a strategic approach to pollution reduction in emerging markets, fostering long-term environmental sustainability while supporting economic growth.

Keywords: Sustainable Supply Chain Management (SSCM), Environmental Pollution, Green Procurement, Economic Development

Introduction

Emerging markets, defined as economies undergoing rapid industrialization and integration into global trade networks, play a critical role in the global economy's growth trajectory. These markets, often located in regions such as Asia, Africa, and Latin America, are characterized by expanding manufacturing sectors, increasing consumer demand, and a significant influx of foreign direct investment (FDI). However, this rapid development has come at a high environmental cost, as industrialization and economic growth in these regions frequently outpace regulatory efforts to mitigate environmental degradation and pollution. Consequently, emerging markets

are now some of the most polluted regions in the world,
with air, water, and soil pollution posing severe risks to human health and ecosystems (Parajuli et al., 2020).
The adverse environmental effects of industrialization have sparked global discourse on the importance of sustainable practices, particularly in supply chain management, where significant environmental impacts originate. Supply chains are the lifeblood of modern economies, responsible for the production, transportation, and distribution of goods. However, traditional supply chain models are often inefficient, resource-intensive, and heavily reliant on fossil fuels, resulting in substantial greenhouse gas emissions and resource depletion (Mangan & Lalwani, 2016). In this context, sustainable supply chain practices (SSCPs) have emerged as a crucial mechanism for reducing environmental pollution while maintaining economic competitiveness.
Sustainable supply chain practices are defined as activities that minimize the environmental impact of supply chains through practices such as green procurement, energy-efficient manufacturing, waste minimization, and the promotion of circular economy principles. These practices have gained prominence in developed economies, where regulatory frameworks and technological advancements support their implementation. However, their adoption in emerging markets has been slower, primarily due to a combination of economic, regulatory, and infrastructural challenges (Zhu et al., 2022). Nonetheless, the growing recognition of the environmental costs associated with unchecked industrialization has led to increased interest in how SSCPs can be effectively implemented in these regions to achieve long-term sustainability goals.

The Environmental Challenge in Emerging Markets

The environmental challenges faced by emerging markets are multifaceted, with pollution being a primary concern. Rapid industrial growth, urbanization, and increased energy consumption have resulted in severe air and water pollution, which is exacerbated by weak environmental governance and insufficient infrastructure for waste management (Meng et al., 2018). According to a World Bank report, more than 90% of the population in low- and middle-income countries is exposed to dangerous levels of air pollution, with emerging markets being the most affected (World Bank, 2020). The textile, chemical, and heavy manufacturing industries are among the primary contributors to environmental degradation in these regions, releasing harmful pollutants into the air and water (Levi & Rothstein, 2019).
One of the key drivers of environmental degradation in emerging markets is the inefficiency of traditional supply chains, which often operate with outdated technologies and prioritize cost minimization over environmental sustainability (Mitra & Datta, 2020). The emphasis on maximizing short-term profits, combined with lax enforcement of environmental regulations, has led to unsustainable practices such as over-extraction of natural resources, excessive energy consumption, and improper waste disposal. These practices not only contribute to environmental pollution but also pose long-term risks to the health and livelihoods of local communities (Das & Singh, 2019).

The Role of Sustainable Supply Chain Practices

In response to these environmental challenges, sustainable supply chain practices offer a pathway for reducing the ecological footprint of industries in emerging markets. SSCPs encompass a range of strategies aimed at integrating environmental considerations into every stage of the supply chain, from raw material procurement to product disposal. One of the most effective SSCPs is green procurement, which involves sourcing materials that have lower environmental impacts and are produced through sustainable methods (Kumar & Shekhar, 2021). By prioritizing suppliers that adhere to environmental standards, companies can reduce the environmental impact of their production processes and promote sustainability across the supply chain.
Another critical aspect of SSCPs is the adoption of circular economy principles, which seek to minimize waste and resource consumption by creating closed-loop systems that prioritize reuse, recycling, and remanufacturing (Geissdoerfer et al., 2017). Circular economy practices are particularly relevant in emerging markets, where waste management infrastructure is often inadequate. By adopting circular economy models, companies can significantly reduce their waste output and lower the overall environmental burden of their operations (Ghisellini et al., 2016).
Energy efficiency is another key component of SSCPs, as supply chain operations are typically energy-intensive, contributing to significant greenhouse gas emissions. By investing in energy-efficient technologies and optimizing production processes, companies can reduce their carbon footprint and enhance their competitiveness in a global market that increasingly values sustainability (Tseng et al., 2019). The use of renewable energy sources, such as solar and wind power, further contributes to pollution reduction by decreasing reliance on fossil fuels (Baker &

Sinkula, 2021).

Barriers to SSCP Adoption in Emerging Markets

Despite the clear environmental benefits of SSCPs, their adoption in emerging markets faces several barriers. One of the primary obstacles is the high upfront costs associated with implementing sustainable technologies and practices. Many companies in emerging markets operate on thin margins, making it difficult to justify the initial investment required for green technologies or renewable energy sources (Jia et al., 2020). Additionally, the lack of regulatory support and enforcement in many emerging markets means that companies are not incentivized to adopt sustainable practices, further limiting their uptake (Qorri et al., 2018).

Another challenge is the lack of awareness and technical expertise needed to implement SSCPs effectively. Many businesses in emerging markets lack the knowledge and resources to develop and execute sustainability strategies, particularly in industries dominated by small and medium-sized enterprises (SMEs) (Zhu et al., 2022). Furthermore, the infrastructural limitations of these regions, including inadequate waste management systems and unreliable access to renewable energy, hinder the successful implementation of SSCPs (Van der Laan & Koster, 2019).

Ssustainable supply chain practices represent a viable solution for reducing environmental pollution in emerging markets. However, for SSCPs to be widely adopted, a concerted effort is needed from governments, businesses, and international organizations to overcome the economic, regulatory, and infrastructural barriers that currently impede their implementation. As the environmental costs of industrialization in emerging markets continue to rise, the adoption of SSCPs is not only necessary for pollution reduction but also critical for the long-term sustainability of these economies.

Methodology

Research Design

This study employs a mixed-methods research design, combining both qualitative and quantitative approaches to analyze the nexus between sustainable supply chain practices (SSCPs) and environmental pollution reduction in emerging markets. The mixed-methods approach was selected to provide a comprehensive understanding of the factors influencing SSCP implementation and their impact on pollution reduction. The research consists of two main components: a quantitative analysis using structured surveys and qualitative insights through case studies. The surveys allowed for the collection of numerical data on SSCP adoption and pollution reduction, while the case studies provided deeper insights into the real-world challenges and outcomes of implementing these practices.

Data Collection

Primary Data:

Primary data were collected using structured surveys, which were distributed to companies operating in emerging markets, specifically in regions such as Asia, Africa, and Latin America. The survey targeted supply chain managers, environmental officers, and executives from industries known for their environmental impact, such as manufacturing, textiles, and chemicals. The survey questions focused on the level of SSCP adoption (e.g., green procurement, waste management, and circular economy practices), the perceived reduction in pollution, and the challenges faced in implementing SSCPs. Responses were captured using a 5-point Likert scale, where respondents rated the extent of their SSCP adoption and its perceived impact on pollution reduction.

Secondary Data:

Secondary data were gathered from various sources, including industry reports, environmental databases from the World Health Organization (WHO) and the World Bank, and academic literature on sustainable supply chains and pollution in emerging markets. This data helped supplement the survey findings by providing objective indicators of pollution levels, including air and water pollution, waste generation, and carbon emissions. These secondary sources also offered context for comparing pollution trends before and after the adoption of SSCPs.

Case Studies:

In addition to survey data, three case studies were conducted with companies from different emerging markets. These companies were chosen based on their notable implementation of sustainable supply chain practices. The case studies involved in-depth interviews with key personnel and a review of the companies' sustainability reports. The case studies aimed to illustrate the specific strategies adopted by these companies, the barriers they encountered, and the outcomes of their efforts in terms of pollution reduction. These qualitative insights complemented the quantitative survey data and provided practical examples of SSCP implementation.

Sample Size and Sampling Method

A purposive sampling method was used to select companies for the survey, focusing on industries with high environmental impact. The sample consisted of 150 companies distributed across emerging markets in Asia (50 companies from China, India, and Vietnam), Africa (50 companies from South Africa, Kenya, and Nigeria), and Latin America (50 companies from Brazil, Mexico, and Argentina). These companies were selected based on their involvement in supply chains with significant environmental footprints, particularly in the manufacturing, textile, and chemical industries. The sample included small, medium, and large enterprises to capture a range of perspectives on SSCP adoption and challenges.

Statistical Analysis

Descriptive Statistics:

Descriptive statistics were used to summarize the data from the surveys. Measures such as mean, median, standard deviation, and frequency distributions were calculated to describe the levels of SSCP adoption, perceived pollution reduction, and challenges faced by companies. This provided an overview of the general trends in sustainable supply chain practices across different regions and industries in emerging markets.

Correlation Analysis:

A Pearson correlation analysis was performed to determine the relationship between SSCP adoption and pollution reduction. The correlation coefficient (r) was calculated to assess the strength and direction of this relationship. The independent variable was the SSCP adoption score, and the dependent variable was the pollution reduction score. This analysis tested the hypothesis that higher levels of SSCP adoption are associated with greater reductions in environmental pollution.

Regression Analysis:

To further explore the impact of SSCPs on pollution reduction, a multiple linear regression analysis was conducted. The dependent variable was the pollution reduction score, while the independent variables included green procurement, waste management practices, circular economy adoption, energy efficiency, company size, and industry sector. This regression model helped identify the relative contribution of each SSCP to pollution reduction and whether certain practices were more effective in specific industries or regions. The model specification is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \epsilon$$

Where:

Y = Pollution reduction score

X 1 = Green procurement score

X2 = Waste management practices score

X3 = Circular economy adoption score

X4= Energy efficiency score

X5= Company size

X6 = Industry sector

ϵ = Error term

This model allowed for an examination of which specific practices contributed most significantly to pollution reduction and helped assess the role of company size and industry sector as control variables.

ANOVA (Analysis of Variance):

An ANOVA was conducted to assess whether there were statistically significant differences in the adoption of SSCPs and pollution reduction across different regions (Asia, Africa, Latin America) and company sizes (small, medium, large). This analysis was crucial for determining whether regional factors or organizational characteristics influenced the effectiveness of SSCPs in reducing environmental pollution.

Factor Analysis:

An exploratory factor analysis (EFA) was performed to identify underlying factors that explain the adoption of SSCPs. The EFA reduced the survey data into key dimensions representing different aspects of sustainable supply chain practices. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were used to ensure the appropriateness of the factor analysis. This analysis helped to uncover the core drivers of SSCP adoption, such as environmental awareness, regulatory pressure, and cost considerations.

Reliability and Validity

Reliability:

The reliability of the survey instrument was tested using Cronbach's alpha, which measures the internal consistency of the survey items related to SSCP adoption and pollution reduction. A Cronbach's alpha value above 0.7 was considered acceptable for ensuring reliability, indicating that the survey questions consistently measured the intended constructs.

Validity:

The validity of the research was ensured through several approaches:

Content Validity: Experts in supply chain management and sustainability were consulted during the development of the survey instrument to ensure that the questions adequately covered the relevant aspects of SSCP adoption and pollution reduction.

Construct Validity: Factor analysis confirmed that the survey items accurately represented the theoretical constructs of sustainable supply chain practices and their impact on environmental pollution.

External Validity: The results from the surveys were cross-validated with the findings from the case studies to ensure consistency between the quantitative and qualitative data.

Limitations of the Study

This study has several limitations. First, the purposive sampling method may introduce bias, as companies with a predisposition towards sustainability might be overrepresented in the sample. Second, the use of self-reported data from surveys may lead to social desirability bias, where respondents overstate their adoption of SSCPs. Additionally, the study focuses on a limited number of emerging markets, which may restrict the generalizability of the findings to other regions. Finally, the cross-sectional nature of the data limits the ability to assess long-term trends in SSCP adoption and pollution reduction.

Ethical Considerations

Ethical approval for the study was obtained from the relevant institutional review boards. Informed consent was sought from all survey participants, and they were assured of the confidentiality and anonymity of their responses. The collected data were stored securely and used solely for the purposes of this research. Participants were informed that they could withdraw from the study at any time without penalty.

Results and discussion

Table 1: Descriptive Statistics of SSCP Adoption and Pollution Reduction

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
SSCP Adoption Score (1-5 scale)	3.45	3.50	0.95	1.00	5.00
Green Procurement Score	3.20	3.00	1.10	1.00	5.00
Waste Management Practices Score	3.75	3.80	0.80	2.00	5.00
Circular Economy Adoption Score	3.10	3.00	1.00	1.00	5.00
Energy Efficiency Score	3.55	3.50	0.85	2.00	5.00
Pollution Reduction Score (1-5)	3.60	3.70	0.90	1.00	5.00

The descriptive statistics in Table 1 provide an overview of the adoption of sustainable supply chain practices (SSCPs) and their perceived impact on pollution reduction. The mean SSCP adoption score across all surveyed companies was 3.45, indicating moderate implementation of sustainable practices. Waste management practices scored the highest (mean = 3.75), suggesting that companies are more focused on reducing waste than other sustainable practices. Green procurement and circular economy adoption scored lower, with means of 3.20 and 3.10, respectively, indicating room for improvement in sourcing environmentally friendly materials and implementing closed-loop systems. The pollution reduction score had a mean of 3.60, reflecting that companies perceive some level of success in reducing environmental impact through SSCPs.

These results suggest that while many companies in emerging markets have started adopting SSCPs, the depth of implementation varies across different practices. Waste management appears to be the most commonly adopted practice, likely because it is more straightforward to implement compared to more complex strategies like green procurement or circular economy principles (Masi et al. 2018).

Table 2: Correlation Between SSCP Adoption and Pollution Reduction

Variable	Green Procurement	Waste Management	Circular Economy	Energy Efficiency	Pollution Reduction
Green Procurement	1.00	0.58**	0.65**	0.50**	0.62**
Waste Management	0.58**	1.00	0.55**	0.60**	0.70**
Circular Economy	0.65**	0.55**	1.00	0.53**	0.68**
Energy Efficiency	0.50**	0.60**	0.53**	1.00	0.66**
Pollution Reduction	0.62**	0.70**	0.68**	0.66**	1.00

$p < 0.01$

The correlation analysis in Table 2 reveals strong, positive relationships between SSCP adoption and pollution reduction. Waste management practices had the highest correlation with pollution reduction ($r = 0.70$, $p < 0.01$), followed by circular economy adoption ($r = 0.68$, $p < 0.01$) and green procurement ($r = 0.62$, $p < 0.01$). Energy efficiency also showed a significant positive correlation with pollution reduction ($r = 0.66$, $p < 0.01$). These results indicate that higher levels of SSCP adoption are associated with greater reductions in environmental pollution.

The strong correlation between waste management and pollution reduction may be attributed to the immediate and tangible effects of reducing waste, such as minimizing landfill use and improving recycling efforts. The positive relationships between green procurement, circular economy, and energy efficiency suggest that adopting a broader range of SSCPs can further enhance pollution reduction efforts (Hassan et al. 2023). However, the slightly lower correlation of green procurement ($r = 0.62$) compared to waste management suggests that many companies still struggle with sourcing sustainable materials, potentially due to cost or availability issues.

Table 3: Multiple Linear Regression Results (Dependent Variable: Pollution Reduction)

Variable	Coefficient (B)	Standard Error	t-value	p-value
Constant (β_0)	1.10	0.50	2.20	0.03*
Green Procurement Score (X_1)	0.22	0.08	2.75	0.01**
Waste Management Practices (X_2)	0.30	0.10	3.00	0.002**
Circular Economy Score (X_3)	0.25	0.09	2.78	0.005**
Energy Efficiency Score (X_4)	0.18	0.07	2.57	0.012*
Company Size (X_5)	-0.05	0.04	-1.25	0.21
Industry Sector (X_6)	0.08	0.05	1.60	0.11

$R^2 = 0.65$, Adjusted $R^2 = 0.63$

*$p < 0.05$, **$p < 0.01$

The multiple linear regression results presented in Table 3 show the individual contributions of different SSCPs to pollution reduction. The overall model was statistically significant ($R^2 = 0.65$, $p < 0.01$), explaining 65% of the variance in pollution reduction. Waste management practices had the largest positive effect on pollution reduction ($\beta = 0.30$, $p < 0.01$), followed by circular economy adoption ($\beta = 0.25$, $p < 0.01$), and green procurement ($\beta = 0.22$, $p < 0.01$). Energy efficiency also contributed significantly to pollution reduction ($\beta = 0.18$, $p < 0.05$).

The significant coefficients for all SSCPs highlight that each practice contributes positively to pollution reduction, with waste management having the most substantial impact. This reinforces the idea that waste management is often the first step companies take toward sustainability due to its immediate effects and relatively lower implementation barriers. Circular economy adoption and green procurement also play important roles, suggesting that more holistic supply chain changes are necessary for achieving substantial pollution reduction (Bag et al. 2022). Interestingly, company size and industry sector were not statistically significant, implying that SSCP adoption's effectiveness in reducing pollution does not vary significantly across different sizes or sectors.

Table 4: ANOVA Results – Differences in SSCP Adoption by Region

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Value	p-value
Between Regions	12.50	2	6.25	5.10	0.007**
Within Regions	145.60	147	0.99		
Total	158.10	149			

$p < 0.01$

Table 5: ANOVA Results – Differences in Pollution Reduction by Company Size

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Value	p-value
Between Groups	8.20	2	4.10	4.05	0.019*
Within Groups	149.90	147	1.02		
Total	158.10	149			

*$p < 0.05$

The ANOVA results in Tables 4 and 5 indicate statistically significant differences in SSCP adoption and pollution reduction across different regions and company sizes. In Table 4, the ANOVA shows a significant regional difference in SSCP adoption ($F = 5.10$, $p < 0.01$), with companies in Asia reporting higher levels of adoption compared to those in Africa and Latin America. This could be due to the stronger regulatory frameworks and greater access to sustainable technologies in Asian emerging markets like China and India (Khan et al. 2019), where governments have implemented stricter environmental policies in recent years.

Table 5 presents the ANOVA results for differences in pollution reduction by company size, with a significant difference observed ($F = 4.05$, $p < 0.05$). Larger companies reported higher levels of pollution reduction, likely due to their greater financial and technical resources, which allow them to invest more in sustainability initiatives. Smaller firms, on the other hand, may face barriers such as higher upfront costs and limited access to green technologies, reducing their ability to adopt SSCPs and achieve similar pollution reduction outcomes.

Table 6: Factor Analysis – Principal Components of SSCP Adoption

Factor	Eigen value	Variance Explained (%)	Factor Loadings
Factor 1: Environmental Awareness	3.75	34.50	Green Procurement (0.78), Circular Economy (0.72), Energy Efficiency (0.70)
Factor 2: Regulatory Pressure	2.10	19.50	Waste Management (0.80), Energy Efficiency (0.55), Green Procurement (0.50)
Factor 3: Cost Considerations	1.20	11.00	Circular Economy (0.65), Waste Management (0.60)

The exploratory factor analysis in Table 6 identified three key dimensions underlying SSCP adoption: environmental awareness, regulatory pressure, and cost considerations. The first factor, environmental awareness, explained 34.5% of the variance and had high loadings for green procurement (0.78), circular economy (0.72), and energy efficiency (0.70). This suggests that companies that are more aware of environmental issues tend to adopt a broader range of sustainable practices.

The second factor, regulatory pressure, explained 19.5% of the variance and had high loadings for waste management (0.80) and energy efficiency (0.55). This indicates that external regulatory forces play a crucial role in driving companies to adopt certain SSCPs, particularly those related to waste reduction and energy use. The third factor, cost considerations, explained 11% of the variance and had high loadings for circular economy (0.65) and waste management (0.60), highlighting that the perceived costs of implementing sustainable practices are a key factor influencing SSCP adoption.

Table 7: Summary of Case Study Findings – SSCP Implementation and Outcomes

Company	Region	Industry Sector	Key SSCPs Implemented	Challenges Faced	Pollution Reduction Outcomes
Company A	Asia	Manufacturing	Green procurement, energy efficiency	High upfront costs, lack of skilled labor	20% reduction in CO_2 emissions
Company B	Latin America	Chemicals	Waste management, circular	Regulatory gaps, lack of infrastructure	30% reduction in hazardous waste

			economy		
Company C	Africa	Textiles	Circular economy, green procurement	Weak enforcement of regulations	25% reduction in water pollution

Note: Companies names were not mentioned due to ethical considerations

The case study findings, summarized in Table 7, provide qualitative insights into the real-world implementation of SSCPs in different regions and industries. Company A, a large manufacturing firm in Asia, implemented green procurement and energy efficiency practices, achieving a 20% reduction in CO_2 emissions. However, the company faced challenges related to high upfront costs and a lack of skilled labor to implement these practices (Bloom & Van Reenen, 2010). Company B, a chemical company in Latin America, focused on waste management and circular economy practices, resulting in a 30% reduction in hazardous waste, though regulatory gaps and weak infrastructure posed significant challenges.

Company C, a textile firm in Africa, implemented circular economy practices and green procurement, reducing water pollution by 25%. However, weak regulatory enforcement in the region hindered the broader adoption of SSCPs. These case studies underscore the importance of regulatory frameworks and company resources in determining the success of SSCP implementation.

The results demonstrate that sustainable supply chain practices can significantly contribute to reducing pollution in emerging markets. Waste management, green procurement, and circular economy principles are particularly effective in lowering pollution levels, as evidenced by both quantitative analysis and case study findings. However, the adoption of these practices varies by region, with companies in Asia leading the way due to stronger regulatory frameworks and better access to sustainable technologies.

The regression analysis reveals that while all SSCPs positively impact pollution reduction, waste management is the most effective. This suggests that companies may prioritize practices with immediate, tangible outcomes, such as reducing waste, before investing in more complex strategies like green procurement or circular economy models.

The factor analysis highlights that environmental awareness and regulatory pressure are key drivers of SSCP adoption. This suggests that policymakers can play a critical role in promoting sustainability by strengthening environmental regulations and raising awareness of the long-term benefits of SSCPs. However, cost considerations remain a significant barrier, particularly for smaller firms and companies in regions with weak regulatory frameworks.

While the adoption of sustainable supply chain practices in emerging markets is growing, significant challenges remain. Policymakers and industry leaders must work together to overcome these barriers by providing financial incentives, strengthening regulations, and building capacity for SSCP implementation.

Conclusion

This study demonstrates the critical role that sustainable supply chain practices (SSCPs) play in reducing environmental pollution in emerging markets. The findings show that practices such as waste management, green procurement, and circular economy adoption significantly contribute to pollution reduction. However, the extent of SSCP adoption varies across regions, with companies in Asia leading in implementation due to stronger regulatory frameworks and access to resources, while firms in Africa and Latin America face more substantial challenges. The research also highlights that regulatory pressure, environmental awareness, and cost considerations are key factors influencing SSCP adoption. Despite the positive impact of these practices, barriers such as high upfront costs, weak regulatory enforcement, and limited technical expertise continue to hinder broader implementation. To achieve widespread adoption of SSCPs and further reduce pollution in emerging markets, there is a need for stronger government policies, greater financial support for companies, and increased awareness of the long-term environmental and economic benefits of sustainable practices.

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