RGSA – Revista de Gestão Social e Ambiental
ISSN: 1981-982X
Submission date: 12/2/2024
Acceptance date: 2/3/2025
DOI: https://doi.org/10.24857/rgsa.v19n3-105
Organization: Interinstitutional Scientific Committee
Chief Editor: Ana Carolina Messias de Souza Ferreira da Costa
Assessment: Double Blind Review pelo SEER/OJS

GREEN SUPPLY CHAIN MANAGEMENT PRACTICES IN SMES IN GUAYAQUIL, ECUADOR

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ABSTRACT

Objective: To analyze the impact of Green Supply Chain Management (GSCM) practices on the environmental performance of SMEs in Guayaquil, evaluating various dimensions such as green purchasing, reverse logistics, waste management, and environmental innovation.

Theoretical Framework: Small and medium-sized enterprises (SMEs) represent a fundamental pillar of Ecuador's and Latin America's economies, generating employment and contributing to sustainable development. However, the adoption of GSCM practices remains a challenge for many due to barriers such as resource scarcity, lack of knowledge, and the need to align business objectives with environmental goals.

Method: This study employed a non-experimental, descriptive, and cross-sectional design. The units of analysis consisted of SMEs in Guayaquil, located in the Guayas province, Ecuador. A purposive sampling method was used, selecting 87 SMEs and applying a questionnaire that measures GSCM practices.

Results and Discussion: The findings indicate that companies have made significant progress in product recovery and recycling at the end of their lifecycle. However, aspects such as ISO 14001 certification and the organization of sustainability seminars reveal an uneven implementation of ecological strategies. Regarding reverse logistics, SMEs recognize the importance of reducing environmental impact and optimizing energy consumption but still face challenges in their effective implementation.

Research Implications: This study underscores the importance of strengthening environmental education in businesses and promoting sustainable innovation policies to enhance the competitiveness and sustainability of Ecuadorian SMEs in a global context.

Originality/Value: The originality of the study lies in its applied focus on SMEs, a sector rarely explored in the Latin American literature on green supply chains. Additionally, it proposes strategies tailored to the Ecuadorian context, considering specific barriers and opportunities in the local market.

Keywords: Green Supply Chain, Environmental Performance, Environmental Innovation, Reverse Logistics, Business Sustainability.

PRÁTICAS DE GESTÃO DA CADEIA DE SUPRIMENTOS VERDE EM PMEs EM GUAYAQUIL, EQUADOR

RESUMO

Objetivo: Analisar o impacto das práticas de Gestão da Cadeia de Suprimentos Verde (GSCM) no desempenho ambiental das PMEs em Guayaquil, avaliando diversas dimensões como compras verdes, logística reversa, gestão de resíduos e inovação ambiental.

Referencial Teórico: As pequenas e médias empresas (PMEs) representam um pilar fundamental da economia do Equador e da América Latina, gerando empregos e contribuindo para o desenvolvimento sustentável. No entanto,

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a adoção de práticas de GSCM continua sendo um desafio para muitas devido a escassez de recursos, falta de conhecimento e necessidade de alinhar objetivos comerciais com metas ambientais.

Método: Este estudo utilizou um desenho não experimental, descritivo e transversal. As unidades de análise foram PMEs de Guayaquil, localizadas na província de Guayas, Equador. Foi aplicado um método de amostragem intencional, selecionando 87 PMEs e aplicando um questionário para medir práticas de GSCM.

Resultados e Discussão: Os resultados indicam que as empresas avançaram significativamente na recuperação e reciclagem de produtos ao final de seu ciclo de vida. No entanto, aspectos como certificação ISO 14001 e organização de seminários sobre sustentabilidade evidenciam uma implementação desigual de estratégias ecológicas. Em relação à logística reversa, as PMEs reconhecem a importância de reduzir o impacto ambiental e otimizar o consumo de energia, mas ainda enfrentam desafios na aplicação eficaz dessas práticas.

Implicações da Pesquisa: Este estudo destaca a importância de fortalecer a educação ambiental empresarial e de promover políticas de inovação sustentável para melhorar a competitividade e sustentabilidade das PMEs equatorianas no contexto global.

Originalidade/Valor: A originalidade do estudo reside no seu foco aplicado às PMEs de Guayaquil, um setor pouco explorado na literatura latino-americana sobre cadeias de suprimentos verdes. Além disso, propõe estratégias adaptadas ao contexto equatoriano, considerando barreiras e oportunidades específicas do mercado local.

Palavras-chave: Cadeia de Suprimentos Verde, Desempenho Ambiental, Inovação Ambiental, Logística Reversa, Sustentabilidade Empresarial.

PRÁCTICAS DE GESTIÓN DE CADENA DE SUMINISTRO VERDE EN PYMES DE GUAYAQUIL, ECUADOR

RESUMEN

Objetivo: Analizar el impacto de las prácticas de gestión de cadena suministro verde (GCSV) en el desempeño ambiental de pymes de Guayaquil, evaluando diversas dimensiones como compras verdes, logística inversa, manejo de residuos e innovación ambiental.

Marco teórico: Las pequeñas y medianas empresas representan un pilar fundamental en la economía de Ecuador y América Latina, generando empleo y contribuyendo al desarrollo sostenible. Sin embargo, la adopción de prácticas de GCSV sigue siendo un desafío debido a barreras como la escasez de recursos, la falta de conocimiento y la necesidad de alinear los objetivos comerciales con los ambientales.

Método: Este estudio adoptó un diseño no experimental, con un enfoque descriptivo y de tipo transversal. Las unidades de análisis estuvieron conformadas por pymes de la ciudad de Guayaquil, provincia del Guayas, Ecuador. Se empleó un muestreo intencional, seleccionando una muestra de 87 pymes aplicando un cuestionario que mide las prácticas de GCSV.

Resultados y discusión: Los resultados indican que las empresas han avanzado significativamente en la recuperación y reciclaje de productos al final de su ciclo de vida. Sin embargo, aspectos como la certificación ISO 14001 y la organización de seminarios sobre sostenibilidad evidencian una implementación desigual de estrategias ecológicas. En cuanto a la logística inversa, las pymes reconocen la importancia de reducir el impacto ambiental y optimizar el consumo energético, pero aún enfrentan desafíos en su aplicación efectiva.

Implicaciones de la investigación: Este estudio concluye la importancia de fortalecer la educación ambiental empresarial y fomentar políticas de innovación sostenible para mejorar la competitividad de las pymes ecuatorianas en el contexto global.

Originalidad/Valor: La originalidad del estudio radica en su enfoque aplicado a pymes, un sector poco explorado en la literatura sobre cadenas de suministro verdes en América Latina. Además, propone estrategias adaptadas al contexto ecuatoriano, considerando barreras y oportunidades específicas del mercado local.

Palabras clave: Cadena de Suministro Verde, Desempeño Ambiental, Innovación Ambiental, Logística Inversa, Sostenibilidad Empresarial.

1 INTRODUCTION

Small and medium-sized enterprises (SMEs) play a crucial role in a country's economy due to the number of jobs they generate, with their production largely oriented toward the domestic market. A large part of the population and the local economy depend on their activities and the positive or negative effects they may have (Ávila and Cedeño, 2020). Although individually their impact may be limited, collectively they can have a significant impact on the regions where they operate. This is especially significant in regions such as Latin America, where SMEs represent 95% of the business community, and in Ecuador, where they constitute 99% (Rodríguez and Avilés, 2020). Therefore, it is essential to recognize the strategic role of these companies in the economy and the economic, social, and environmental impact that their activities generate together (Sarango *et al* ., 2018).

In this sense, SMEs have the potential to play a crucial role in achieving the sustainable development goals established by the United Nations. In a society increasingly aware of the importance of addressing environmental and social challenges, SMEs and sustainable entrepreneurship are emerging as a promising solution for promoting equitable and responsible growth (Calanchez et *al.,* 2022; Huamán *et al.,* 2022).

However, the challenge lies in aligning business objectives with environmental ones, overcoming market barriers, and securing the necessary funding and support to scale green innovations . The market for green products and services is expanding rapidly, and consumers are increasingly seeking sustainable options. Shifting consumer preferences create an opportunity for entrepreneurs to provide green solutions while meeting market demands. Significant growth in green consumption offers an opportunity for companies to provide sustainable transportation, so a paradigm shift in the business ecosystem is needed to capitalize on these opportunities. Entrepreneurs must integrate their metrics. traditional commercial with environmental performance indicators . This requires support from policymakers, investors and consumers and innovative thinking for sustainability (Rasheed *et al.* 2024a).

While environmental research in SMEs remains underdeveloped (Belas *et al.*, 2021), insights from studies on the implementation of sustainability practices in all types of businesses are also applicable to SMEs. A recurring finding is that SMEs face pressures and barriers in implementing sustainability activities (Jansson *et al.* , 2017 ; Meath *et al.*, 2016). One of these barriers is the scarcity of their resources, such as production factors, information, knowledge, support, time, and tools to address green practices (Quintás *et al.*, 2018 ; Yacob *et al.* , 2019).

To meet the ever-increasing demands for sustainable products and services, the field of entrepreneurship is a potential domain where entrepreneurs can promote a green and sustainable world (Albhirat *et al.*, 2024). Through these approaches, entrepreneurs can leverage green innovations and GCSV practices to create new profitable and eco-friendly business opportunities (Mathushan and Pushpanathan, 2020).

Green supply chain management is a comprehensive approach that encompasses all of a company's activities, taking into account their environmental impacts. It includes planning and managing manufacturing processes to reduce greenhouse gas emissions and waste, and adopting recycling and disposal practices (Iqbal *et al.*, 2020 ; Rasheed *et al.*, 2024 b).

The objective of this research was to analyze the impact of green supply chain management (GSCM) practices on environmental performance in small and medium-sized enterprises in Ecuador.

2 THEORETICAL FRAMEWORK

GCSV is a comprehensive approach that encompasses all of a company's activities and considers their environmental impacts. It includes planning and managing manufacturing processes to reduce greenhouse gas emissions and waste, and adopting recycling and disposal practices (Iqbal *et al.*, 2020 ; Rasheed *et al.*, 2024a ; Rasheed et al., 2024b).

Supply chain greening practices include innovations in procurement, production, distribution, and logistics processes; therefore, to successfully implement supply chain greening, firms need to leverage significant efforts to change or adapt their products, processes, and management, often with the adoption of new business models. Business innovation processes are critical to making these efforts less costly and more effective (Silva *et al.*, 2019).

The adoption of SCM practices involves changes in a company's technical systems that require innovative processes throughout the supply chain. Innovations in processes, products, organizations, and marketing will develop and improve as these practices mature (Jabbour and

De Sousa, 2016); as a result, companies will become more innovative in all their endeavors, not just their environmental aspects (Sancha *et al.*, 2015).

The literature review revealed that implementation of GCSV practices in organizations helps in managing waste and increases environmental sustainability and business performance (Rupa and Saif , 2022) . A study by Das *et al.* (2023) examining the impact of GCSV and environmental management system of firms revealed increased customer satisfaction, improved internal collaboration, decreased waste, and reduced costs.

Some of the GCSV practices that are mainly used in the industry in detail:

- Supplier Interaction on Environmental Sustainability: Participating in green sustainability practices involves information exchange and collaboration among supply chain organizations on environmental expertise and developing joint sustainability planning efforts (Vachon and Klassen, 2008). Implementing this conscious practice improves supply chain integration, yielding advantages in supplier cooperation similar to other non-green supply chain activities.
- Environmentally friendly purchasing practices: Despite the higher cost of green products, their use can benefit an organization's image and resource conservation efforts (Min & Galle, 2019). Using green purchasing techniques mitigates unnecessary purchases, leading to a reduction in environmental costs .
- Waste reduction: Waste management refers to the processes and actions required to manage waste from its source to its final disposal. This includes collection, transportation, treatment, disposal, monitoring and regulation of the waste management process, as well as waste-related laws, technologies, and economic mechanisms (Pongrácz *et al.,* 2004). The objective of waste management is to effectively control and reduce waste generation after its production, as suggested by Al Khidir and Zailani (2009). Lean methodologies use an ecological approach to minimize waste and eliminate non-value-added processes along the supply chain.
- Collaborate with designers and suppliers to minimize and eventually eliminate a product's environmental impact. According to Tsoulfas and Pappis (2006), designers should evaluate energy and material requirements throughout a product's entire life cycle, including its manufacture, consumption, and future use. Collaborating with crucial suppliers in product development reduces the time to market. Reducing both commercial waste and environmental costs is accompanied by increased consumer satisfaction.

- Reducing the consumption of hazardous and toxic materials in the green supply chain, which involves a systematic approach to minimizing environmental impact and improving safety for both workers and consumers. This strategy is based on identifying, replacing, and eliminating materials that could harm the environment or human health during their life cycle.
- Customer engagement on environmental issues: Effective customer engagement improves quality and customer service by reducing supply chain costs and preserving operational reliability (Assumpção *et al.* , 2022).
- Environmentally friendly packaging: These strategies focus on the design, selection, and use of materials and methods that minimize environmental impact throughout the product's lifecycle, from manufacturing to final disposal. This strategy is key to the green supply chain because it allows companies to reduce waste, optimize resources, and meet growing demands for sustainability from consumers and regulators.

The adoption of these strategies not only responds to internal benefits but also to growing pressure from stakeholders and regulators. Consumers, investors, and government agencies increasingly demand that companies assume greater responsibility for reducing their environmental impact. This has led to the incorporation of environmental requirements throughout the entire supply chain, from supplier selection to product manufacturing and final distribution (Payán et al., 2019). In this sense, the implementation of GCSV not only represents a competitive advantage but also becomes a necessity to ensure business sustainability and compliance with environmental regulations in an increasingly demanding market (Gölgeci and Kuivalainen, 2020; Silva et al., 2021).

3 MATERIALS AND METHODS

This study adopted a non-experimental design with a descriptive, cross-sectional approach. The units of analysis consisted of SMEs from different economic sectors, including production, distribution, and input and waste management operations, located in the city of Guayaquil, in the province of Guayas, Ecuador. Purposive sampling was used, selecting a sample of 87 SMEs .

For data collection, the survey was used as the main technique, while the questionnaire used by Rasheed et al. (2024a) was the applied instrument, it consisted of 44 strategically designed questions, each formulated with the purpose of obtaining relevant information in

seven dimensions: green design, green operations, reverse logistics, green purchasing, reverse logistics implementation, waste management and environmental performance. The structure of the instrument included five response options, categorized as follows: Strongly agree, agree, neither agree nor disagree, disagree and strongly disagree, assigning them values of 5, 4, 3, 2 and 1, respectively. The criterion was established that for any item with a mean of 2.50 or higher, this practice was considered to be carried out in SMEs, while those with a mean below 2.50 indicate that this practice is not carried out, following the methodology proposed by Carrasquero (2024).

To ensure the instrument's validity, it was evaluated by a panel of five experts, in addition to a reliability test. The questionnaire's internal consistency was assessed using Cronbach's alpha coefficient, yielding a result of 0.940, indicating a satisfactory level of reliability.

The collected data were analyzed using descriptive statistics, including the calculation of the mean and standard deviation. A box-and-whisker plot was constructed to compare the dimensions evaluated. Similarly, the Kolmogorov-Smirnov test was applied to analyze the normal distribution of the residuals. As the results did not comply with normality, a Spearman correlation analysis was performed.

4 RESULTS AND DISCUSSION

Table 1 presents the demographic distribution of the study. The results show that the majority of respondents are men (70%), while women represent 30%. This distribution suggests that the sector in which these SMEs operate could be dominated by men, which is consistent with previous studies indicating that certain industries, such as manufacturing and logistics, tend to have a greater male presence in leadership and decision-making roles in sustainability (Belas *et al.,* 2021).

Demographic data show that decision-makers in SMEs have an experienced and highly educated profile, which can facilitate the adoption of green supply chain management strategies. However, the low representation of women and the absence of young people with less than three years of experience could limit the diversification of perspectives in the implementation of sustainable and innovative practices. Previous research has identified that educational level is a determining factor in the implementation of sustainable business strategies, as it facilitates the understanding of the long-term benefits of the circular economy and the reduction of environmental impact (Sancha *et al.,* 2015). Previous studies have identified that companies

with experienced leaders and advanced academic training tend to be more receptive to the adoption of sustainability strategies, although generational and gender diversity also play a key role in the generation of new ideas and innovative approaches (Jabbour *and* De Sousa, 2016).

Table 1

Demographic Distribution of Study Participants

Demographic category	Profiles	Frequency	Percentage
Gender	Male	61	70
	Female	26	30
Age	23 to 28 years old	9	10
	29 to 34 years old	17	20
	35 to 40 years old	17	20
	Over 40 years old	44	50
Education	Secondary	9	10
	Graduate	17	20
	Postgraduate	61	70
	Doctorate	0	0
Experience	Less than three years	0	0
	3 to 6 years	17	20
	7 to 10 years	9	10
	More than ten years	61	70
Company Age	More than ten years	44	50
	6 to 10 years	26	30
	4 to 5 years	0	0
	Less than 4 years	17	20

Table 2 presents the means and standard deviations of the responses obtained regarding green supply chain management practices across the following dimensions: green design, green operations, and reverse logistics. End-of-life product recovery and recycling obtained the highest score (4.30 ± 0.78), indicating that most SMEs have implemented key practices for waste reduction and compliance with environmental regulations.

Environmentally friendly packaging design (3.79 ± 0.75) and the use of eco-labeling (3.78 ± 1.26) show slightly lower values and greater variability in responses, suggesting that these practices are not yet fully integrated in all the companies surveyed.

Table 2

Results of the dimensions green design, green operations and logistics.

Dimensions		Ask	Average	OF
Green supply chain management	Green design	Uses low-polluting or non-toxic materials	3.99	0.64
		Design or improve packaging to be environmentally friendly (e.g., by using less paper and plastic materials)	3.79	0.75
		Recover end-of-life products and recycle them	4.30	0.78
		Use eco-labeling	3.78	1.26
	Green operations	Conducts environmental audits of suppliers	3.29	1.29
		It has ISO14001 Certification	2.01	0.45

	Check whether your suppliers comply with specific regulations such as emission limits, hazardous materials labeling, product specifications, and documentation.	3.17	1.34
	Organizes seminars and workshops on green supply chains	2.78	1.43
	Manages the reverse flow of materials	2.99	1.29
Reverse logistics	Control environmental risks associated with supplier operations during reverse logistics	3.49	1.04
	Ensures proper use of materials by customers	3.07	1.24

Environmental audits of suppliers (3.29 ± 1.29) and verification of compliance with environmental regulations by suppliers (3.17 ± 1.34) present moderate values, indicating that some companies carry out environmental controls, but their implementation is not uniform in all the SMEs surveyed.

ISO 14001 certification (2.01 ± 0.45) has the lowest score in the dimension, which shows that few companies have opted for this certification, possibly due to costs, lack of awareness, or lack of regulatory incentives. Sancha *et al. (* 2015) highlight the importance of ISO 14001 certification in the environmental management of companies. However, as in this research, these authors found that the adoption of this certification is low due to costs.

The organization of seminars and workshops on G CSV (2.78 ± 1.43) also has a low score, indicating that internal training on environmental management in the supply chain is not prioritized. The control of environmental risks associated with reverse logistics (3.49 ± 1.04) is the best-rated practice within this dimension, which indicates that some SMEs have taken measures to mitigate environmental impacts in their product return processes.

The results obtained for the dimensions : green purchasing and reverse logistics implementation suggest that SMEs in Guayaquil are making progress in adopting sustainable practices, particularly in reverse logistics (Table 3). However, challenges persist in implementing green purchasing strategies and effectively integrating sustainable suppliers.

Supplier collaboration is essential for green supply chain practice and improving environmental performance (Govindan *et al* ., 2015) . Few studies highlight the importance of multi-tier supplier collaboration ; however, Das and Jharkharia (2018) establish that it is crucial for logistics service providers (LSPs) to adopt green supply chain practices (Tseng *et al* ., 2018). LSPs play a critical role in the transportation and distribution of goods in both upstream and downstream supply chain networks, which can have a significant impact on the environment.

The results obtained in reverse logistics are consistently higher than in green purchasing, indicating that companies have made more progress in raising awareness about sustainability in logistics than in integrating green criteria into supplier selection. The low score obtained in

supplier integration in the supply chain suggests that many SMEs still prioritize cost and efficiency over sustainability criteria.

Regarding the waste management and environmental performance dimensions, the surveyed companies showed a positive trend in implementing recycling practices within the production process (3.78 ± 0.74) and in having separate disposal points for hazardous and non-hazardous waste (3.99 ± 0.78). However, the constant monitoring of waste for its minimization (3.78 ± 1.19) also reflects a certain level of variability in implementation, indicating the need to strengthen systematic strategies for efficient waste management (Table 4).

Table 3

Results of the green purchasing and reverse logistics implementation dimensions.

Dimensions		Ask	Average	OF
Green supply chain management	Green shopping	Has included green supply chain management strategies in its strategic purchasing process	3.39	0.81
		It has suppliers integrated into the supply chain in order to reduce costs and improve customer service.	3.30	0.65
		Improving purchasing performance (customer base/loyalty)	3.40	0.67
		Requires suppliers to develop/maintain an environmental management system	3.70	0.92
	Implementation of reverse logistics	The company recognizes logistics as one of the most critical developments in the supply chain and transportation industry.	3.93	0.94
		The company recognizes "green" as a critical factor in its environmental impact assessment.	4.43	0.90
		The company recognizes the need for environmentally friendly products and reduces energy consumption to reduce costs and increase customer base.	4.31	0.78
		The company recognizes the need to advocate for green processes to eliminate waste and pollution and conserve the environment.	4.32	0.78
		The company considers the effect of its productive activities on the environment and society	4.31	0.65

A relevant aspect identified in the results is the relationship between sustainability and business profitability. Practices focused on cost reduction through sustainable strategies (3.89 ± 1.05) and improving business profits through environmental actions (3.91 ± 0.96) reflect a positive perception of sustainability as a strategic factor within the business model. However, the results also suggest that there are still opportunities for improvement, especially in reducing operational waste (3.77 ± 1.09) and pollution (3.67 ± 1.01), areas where the dispersion of data reflects differences in the application of these strategies among the companies surveyed.

Table 4

Results of the waste management and environmental performance dimensions.

Dimensions	Ask	Average	OF
Waste management	Implement waste recycling practices in the production process	3.78	0.74
	Provides disposal points for hazardous and non-hazardous waste	3.99	0.78
	Keep hazardous and non-hazardous waste in separate containers.	3.68	1.29
	Constantly monitor the waste generated to minimize it.	3.78	1.19
	Uses business innovations to reduce the consumption of hazardous, harmful, or toxic materials such as carbon emissions and solid waste	3.78	0.87
	They reduce the consumption of materials and resources (such as water, electricity, gas and gasoline) and decrease the frequency of environmental accidents.	3.68	1.10
Environmental performance	Improves compliance with corporate environmental regulations	3.98	1.01
	Promotes the reuse and recycling of raw materials and avoids fines for violating corporate environmental regulations.	4.08	0.96
	Implement strategies to reduce the frequency of environmental accidents	3.89	1.05
	Incorporates waste management practices	3.87	0.95
	Reduces waste resulting from operations	3.77	1.09
	Reduce waste from pollution	3.67	1.01
	Recycle waste products	3.89	1.16
	Implement practices that reduce the cost of products in new ways	3.89	1.05
	Implement practices that seek to improve your organization's profits	3.91	0.96
	Implements improvements in compliance with environmental regulations due to the practice of sustainable actions	4.08	0.96

Initiatives to redefine production and operational processes to ensure internal efficiency (3.70 ± 0.92) and the redesign of products or services to meet new environmental criteria (3.70 ± 0.79) demonstrate moderate commitment, although with opportunities for improvement. A positive aspect is that companies have begun to encourage employees to take a responsible approach to waste disposal (3.80 ± 0.89), indicating a growing organizational awareness of sustainability (Table 5).

Table 5

Results of the dimensions Green Process Innovation and Green Management Innovation.

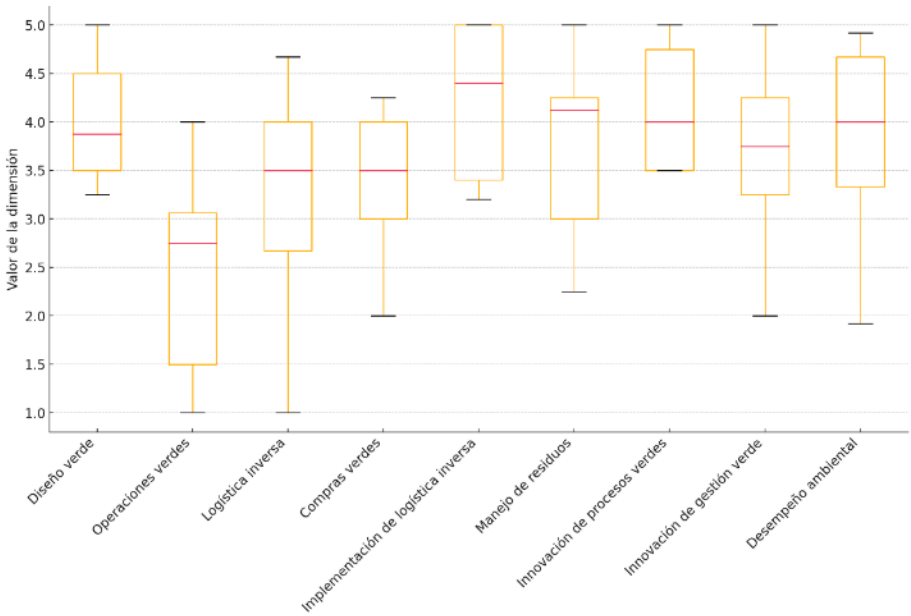
Dimensions		Ask	Average	OF
Green innovation	Green process innovation	Implement low resource consumption practices (e.g. water, electricity, gas, etc.) during production.	4.10	0.70
		Use clean technologies to save and avoid pollution such as energy, water and waste.	4.21	0.75
		Implement recycling, reuse and reuse of internal materials within the company	4.40	0.49
		Invest in plants, equipment, lighting, heating and services adapted to environmental assessment	4.00	0.91
	Green management innovation	Redefines production and operating processes to ensure internal efficiency	3.70	0.92
		Redesign and improve products or services to meet new environmental criteria or directives	3.70	0.79

Encourage employees to adopt a responsible attitude in waste disposal	3.80	0.89
Manages environmental audits periodically and implements corrective actions	3.48	1.23

The overall analysis of the dimensions analyzed reveals significant disparities in the adoption of sustainable practices. The box and whisker plot (Figure 1) identifies the highest-rated dimensions as waste management and green process innovation, with high medians and low dispersion in responses. This indicates that most SMEs have implemented effective strategies for waste reduction and optimization of their production processes. The implementation of reverse logistics showed high values in many cases, suggesting a growing awareness of the importance of recovering and reusing materials within the supply chain. Green operations and reverse logistics presented high variability in responses, indicating that while some companies have incorporated environmental audits and reverse logistics strategies, others have not yet integrated these practices consistently.

Figure 1

Comparing dimensions using box and whisker plots



Green purchasing practices reflect moderate implementation, with a median score close to 3.5, suggesting that not all SMEs have integrated environmental criteria into supplier selection and input procurement. The adoption of environmental certifications, such as ISO 14001, remains low, limiting the consolidation of formal sustainability strategies in the companies evaluated. Environmental training and awareness strategies need to be strengthened,

especially in areas with high variability in the implementation of sustainable practices. Integrating reverse logistics and green operations into strategic business planning could contribute to greater efficiency in environmental management, promoting a circular approach within the supply chain.

Environmental certification and auditing programs must be promoted to standardize sustainability practices in SMEs. Incentives must also be provided for the implementation of reverse logistics and green purchasing strategies, reducing dependence on polluting materials and strengthening circularity in the supply chain. Furthermore, policies for innovation in green management must be developed, facilitating access to emerging technologies that optimize business processes and minimize environmental impacts.

From Spearman's correlation analysis, there was a strong positive correlation between green design and environmental performance (r: 0.853, p: 0.000), indicating that companies that incorporate green materials and sustainable design into their products tend to have better environmental performance (Table 6). This finding is consistent with the study by Rasheed *et al.* (2024a), which highlights that SMEs with proactive approaches to green practices generate greater competitive advantage and better regulatory reputation.

Table 6

Spearmen correlation analysis of the evaluated dimensions

	Green Design	Green Operations	Reverse Logistics	Green Shopping	Implementation of Reverse Logistics	Waste Management	Green Process Innovation	Green Management Innovation
Green Operations	.631 **							
P	.000							
Reverse Logistics	.371 **	.523 **						
P	.000	.000						
Green Shopping	.409 **	.504 **	.826 **					
P	.000	.000	.000					
Implementation of Reverse Logistics	-.319 **	-.317 **	-.321 **	.148				
P	.003	.003	.002	.173				
Waste Management	.380 **	.246 *	.097	.032	-.258 *			
P	.000	.022	.370	.770	.016			
Green Process Innovation	.404 **	.116	.429 **	.456 **	.164	-.416 **		
P	.000	.286	.000	.000	.130	.000		
Green Management Innovation	.690 **	.653 **	.215 *	.412 **	-.007	.129	.197	
P	.000	.000	.046	.000	.946	.233	.067	

Environmental Performance	.853 **	.600 **	.176	.222*	-.208	.500**	.216*	.702**
p	.000	.000	.104	.039	.054	.000	.045	.000

A moderate positive correlation was also observed between green design and operations (r:0.631, p:0.000), suggesting that firms that implement green design are also strengthening environmental audits and certifications. Similar results were found by Mafini and Muposhi (2007), who showed that green supply chain management practices related to design and manufacturing positively affect environmental performance in SMEs. Tang et al. (2017) and Al Khataab and As'ad (2015) have suggested that green innovation significantly influences a firm's environmental performance and, consequently, business efficiency (Debnath *et al* ., 2023).

The successful implementation of green supply chain practices contributes to improved performance across several dimensions, including environmental, operational, financial, and social aspects. However, companies must collaborate with their supply chain partners to effectively implement these practices.

5 CONCLUSIONS

The study results indicate that SMEs in Guayaquil have made progress in implementing green supply chain management practices, particularly in areas such as recycling, material reuse, and reducing energy consumption. However, the adoption of environmental certifications and the integration of suppliers into sustainable strategies still present challenges. This suggests the need for policies that incentivize training, certification, and financing to strengthen sustainability in the sector.

A significant positive correlation was found between green design and environmental performance, suggesting that companies that prioritize the use of eco-friendly materials and sustainable strategies achieve better environmental outcomes. Furthermore, innovation in green processes and management has proven to be a key factor in improving the efficiency and sustainability of business operations, although its implementation varies depending on the resources and infrastructure available at each company.

Despite efforts to adopt sustainable practices, a lack of technical knowledge and clear regulations continue to be barriers to the effective implementation of GCSV in SMEs. Therefore, it is essential to strengthen corporate environmental education, promote training in sustainable innovation, and establish more specific public policies and regulations that incentivize the adoption of green strategies in the supply chain.

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