Exploring the Impact of Sustainable Development Strategies on SME Performance: A Sector, Size, and Age Perspective

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Abstract

Purpose: This study conducts a comparative analysis of the impact of sustainable development approaches on the organizational performance of Small and Medium-sized Enterprises (SMEs) in Colombia, segmented by sector, size, and age. **Methodology:** The research employed a descriptive and quantitative evaluation based on primary data from a survey of 4,600 SMEs across five regions of Colombia. Furthermore, a Neural Network model was utilized to explain how the importance of specific characteristics (behavior, attitude, and knowledge) related to sustainability varies in relation to organizational performance depending on the company's sector, size, and age. **Findings:** The main findings reveal significant differences in attitude, behavior, and knowledge regarding the barriers and benefits of implementing environmental strategies aligned with SDG 12 ("Responsible Consumption and Production"). While some SMEs are achieving a considerable level of corporate sustainability, others remain in the nascent stages of this journey. This result suggests that there is substantial room for Colombian SMEs to enhance the integration of sustainable practices into their business operations. **Originality:** This study provides a valuable large-scale comparative view of SDG implementation within the Colombian SME context, offering a robust empirical basis for future research and strategies aimed at fostering sustainability and the circular economy in the region.

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Introduction

Small and Medium-sized Enterprises (SMEs) are widely recognized as the backbone of national economies, playing a crucial role in producing goods and services, creating employment, and reducing income inequality (Olah et al., 2019). In the Ibero-American context, and specifically in Colombia, SMEs are fundamental to economic and socioeconomic development (Restrepo-Morales et al., 2019; Chege & Wang, 2020). In an era of globalization and accelerated change, all companies, regardless of size or industry, must adopt effective business strategies to remain competitive (Borocki et al., 2019). Factors such as increasing interconnectedness, open innovation, mass customization, and fluctuating tax policies shape a dynamic global landscape that affects all sectors (Androniceanu et al., 2019). For Colombian SMEs, this environment presents a unique set of challenges and opportunities that demand strategic adaptation (Mazo et al., 2020; Arboleda et al., 2020; Franco & Londoño, 2022).

Furthermore, the growing emphasis on corporate social responsibility (CSR) and sustainability has compelled SMEs to integrate these principles into their core operations and strategies (Sroka & Vveinhardt, 2018; Groucutt et al., 2018). This imperative represents both a challenge and a significant opportunity for differentiation and value creation (Sánchez et al., 2022). The performance and contribution of SMEs vary depending on numerous economic, cultural, and environmental factors, justifying the need for continuous investigation (Sinicáková et al., 2017; Ivanová & Čepel, 2018).

At a global level, SMEs are fundamental to advancing the Sustainable Development Goals (SDGs) proposed by the United Nations (UN, 2015; Caldera et al., 2018). The SDGs that are particularly relevant for SMEs include SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 12 (Responsible Consumption and Production) (Martínez & Poveda, 2021). However, adopting these sustainable goals and participating in a circular economy poses considerable challenges for both policymakers and entrepreneurs (Guzmán et al., 2021; Howard et al., 2022).

This study examines the extent to which SMEs in Colombia integrate the principles of environmental sustainability into their operations. It does so through an analysis of three latent variables: **behavior**, **attitude**, and **knowledge**. The results provide a crucial starting point for a more comprehensive cross-border assessment in the Ibero-American context. The document is structured as follows: a review of the literature, a detailed methodology, a presentation and discussion of the results, and finally, the conclusions of the study.

2. Literature Review

2.1. Importance of SMEs

Since the 1980s, the role of SMEs as engines of economic growth and job creation has become particularly pronounced in Latin America. According to the guidelines of the Andean Community (CAN), to which Colombia belongs, SMEs are defined as having up to 200 employees and annual sales or total assets of less than $5 million (Andean Community, 2009). SMEs are the cornerstone of the economy due to their widespread presence across all sectors (Velinov & Ponomarev, 2016; Ali et al., 2022). Their value has grown sustainably, and they are now considered powerful engines of global economic development (Bădulescu, 2010; Karpak & Topcu, 2010; Meyer & De Jongh, 2018; Androniceanu, 2019).

In Colombia, SMEs account for a significant proportion of businesses and are the largest generators of employment (Duran & Mancha-Navarro, 2020), which not only stimulates the economy but also helps reduce income inequality (Parra et al., 2021). This importance is attributed to their inherent dynamism, capacity for innovation, and efficiency. Their smaller size allows for more agile decision-making compared to large corporations (Mehdi & Singh, 2023). Consequently, many

SMEs view internationalization and inter-firm cooperation as key strategies for survival and growth in competitive markets (Massaro et al., 2017; Gallegos, 2022). In the Colombian context, collaboration and the adoption of environmental strategies can provide SMEs with access to new markets, technologies, and competencies, thus mitigating some of the challenges they face (Kolbe et al., 2022).

2.2. Context of SME Sustainability in Colombia

The sustainability of SMEs in Colombia has become an increasingly critical topic. The adoption of sustainable practices is now necessary to ensure long-term competitiveness and survival (Fals-Borda, 2017). Seminal work have long argued that sustainable firms can achieve competitive advantages through cost reduction, improved operational efficiency, and access to new markets (Porter & Van der Linde, 1995), as well as enhancing corporate image and customer relationships (Hart, 1995).

Recent studies corroborate these arguments for Colombian and similar contexts. For instance, López-Gamero et al. (2011) found that Spanish SMEs adopting sustainable practices experienced significant improvements in operational efficiency. Similarly, Becerra & Contín-Pilart (2017) concluded that implementing sustainable practices in Colombian SMEs can increase productivity and competitiveness.

The adoption of these practices is influenced by several factors. Environmental awareness of entrepreneurs is a key driver in decision-making (Bernal et al., 2019). Additionally, the availability of financial resources (Mendoza et al., 2018) and appropriate staff training (Vallejo-Ángel et al., 2017) are crucial for implementing sustainable transformations. However, significant obstacles remain, including a lack of awareness of the benefits (Álvarez-Castaño et al., 2016), a lack of financial and technological resources (González-Benito et al., 2019), and a lack of specific knowledge and skills (Becerra & Contín-Pilart, 2017).

2.3. Role of Eco-Innovation

Eco-innovation is key to the future of the Ibero-American region and is central to Andean Community policy. Colombia's economic prosperity is intrinsically linked to its natural environment, and the global demand for renewable energy and resource-efficient solutions will be a source of future jobs and economic growth (Zimmermanová et al., 2018). Eco-innovation is a powerful tool that combines a reduced environmental impact with positive economic and social outcomes (Mikiashvili & Lobzhanidze, 2017), highlighting the contribution SMEs can make to sustainable development (Lesáková, 2019).

While Colombia does not have a specific ranking like the European Eco-Innovation Scoreboard, the need for eco-innovation is equally relevant. Colombian SMEs are in a unique position to drive innovation in this area by leveraging government incentives designed to stimulate demand for eco-innovative products and services. Collaboration with research centers, technology parks, and educational initiatives is fundamental to fostering a sustainable and competitive future for Colombian SMEs (Urbaniec & Gerstlberger, 2011; Ferenc et al., 2017). The Colombian government has recognized this need and has developed incentives, including favorable funding policies and tax breaks, to promote and support sustainable growth and create a culture of eco-innovation across the country.

3. Methodology

To evaluate the implementation of environmental strategies and their impact on the organizational performance of SMEs in Colombia, the methodological phases outlined in Table 1 were followed.

Table 1. Methodological phases applied in this study.

Population	SMEs in different industrial sectors in Colombia.
Sample	4600 SMEs surveyed by FaedPyme (2022).
Data collection	The data collection tool was an online questionnaire. Entrepreneurs rated their agreement or disagreement with each statement on a 5-point Likert

instrument	scale (1 = not important at all to 5 = very important). Questions characterizing the sample of SMEs by size, age and sector were also included.
Distribution and collection of data	The questionnaires were distributed by email or in person, as needed. The collected data was anonymized and stored securely.
Data analysis	Statistical analysis techniques, including descriptive analysis and hypothesis testing, were used to interpret the data. A neural network was also used to look for patterns and trends that indicate possible connections between the answers and the characteristics of the companies

Source: Authors.

Based on the study's objective, the following hypotheses were proposed:

- **Hypothesis 1 (H1):** The integration of environmental criteria in business operations (behavior) is positively associated with organizational performance.
- **Hypothesis 2 (H2):** SMEs that recognize the benefits of sustainability (attitude) are more likely to exhibit higher organizational performance.
- **Hypothesis 3 (H3):** SMEs with a high level of knowledge regarding sustainability barriers (knowledge) are less likely to exhibit higher organizational performance.

To measure the three latent variables, a set of observable variables was constructed for each, as shown in Table 2.

Table 2. Schematic of the latent variables of the study.

Variable name	*Latent variable 1: Behaviour*
P016_SQ001	Environmental criteria in the selection of suppliers
P016_SQ002	Environmental criteria in the management of plastic packaging and derivatives
P016_SQ003	Environmental criteria in process design
P016_SQ004	Environmental criteria for energy management
P016_SQ005	Environmental criteria in water management
P016_SQ006	Environmental criteria in waste management
P016_SQ007	Environmental certifications (e.g., ISO14001 / EMAS)
	Latent variable 2: Attitude
P017_SQ001	Sustainability increases employee motivation
P017_SQ002	Sustainability in the company generates advantages over the competition
P017_SQ003	Adopting sustainable policies improves the image and reputation of the company
P017_SQ004	Sustainability increases the profitability of the company
P017_SQ005	Sustainability increases the degree of satisfaction of our customers
	Latent variable 3: Knowledge
P018_SQ001	Implementing sustainable development is too costly for the company
P018_SQ002	We don't have enough time to worry about social and environmental issues
P018_SQ003	The development of sustainability actions can cause us a loss of competitiveness
P018_SQ004	There are difficulties in financing projects related to sustainability
P018_SQ005	Lack of environmental training of company personnel
P018_SQ006	Environmental regulations are complex to apply

Source: Authors.

Organizational performance was measured across four dimensions: financial performance, operational efficiency, employee performance, and customer satisfaction. Each dimension was assessed using four associated variables, detailed in Table 3.

Table 3. Organizational Performance Measurement Variables.

Organizational Performance		
Financial Performance	*Revenue Growth*	Assesses the rate at which the organization's revenue has increased over a specific period.
	Profitability	At the organization's ability to generate profits from its operations.
	Return on Investment (ROI)	Evaluates the efficiency of an investment or compare the efficiency of several different investments.
	Market Share	Analyzes the portion of a market controlled by a particular product or company.
Operational Efficiency	*Process Efficiency*	Assesses the effectiveness of the organization's operational processes.
	Cost Efficiency	Examine how well the organization minimizes costs in its operations.
	Resource Utilization	Measures how efficiently the organization utilizes its resources.
	Supply Chain Efficiency	Evaluates the effectiveness of the organization's supply chain operations.
Employee Performance	*Employee Productivity*	At the output of each employee relative to the input.
	Employee Satisfaction	Evaluates the degree to which employees are content with their work environment and role.
	Employee Retention	Measures the organization's ability to retain its employees over time.
	Employee Engagement	Examine the emotional commitment the employee has to the organization and its goals.
Customer Satisfaction	*Customer Retention*	At the organization's ability to retain its customers over time.
	Customer Satisfaction Rating	Assesses the degree to which customers are satisfied with the organization's products or services.
	Customer Loyalty	Examine the likelihood that existing customers will continue to do business with the organization.
	Net Promoter Score (NPS)	Measures customer experience and predicts business growth.

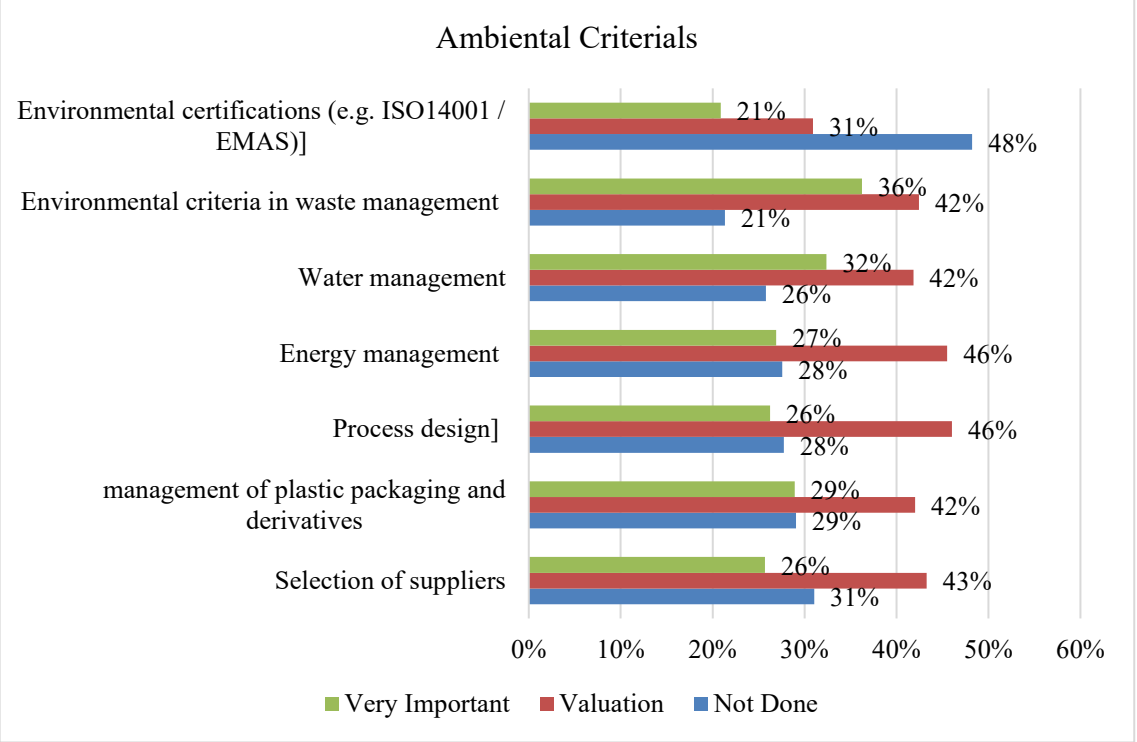
Source: Authors.

4. Results

4.1. Environmental Practices

The importance and implementation of environmental criteria are depicted in Figure 1. Overall, supplier selection and plastic packaging management are not practiced by approximately one-third of SMEs (31% and 29%, respectively), suggesting these are lower-priority criteria. Conversely, waste management and water management are considered the most important criteria (36% and 32%, respectively), indicating a greater focus in these areas. Notably, obtaining environmental certifications (e.g., ISO14001/EMAS) was the least applied criterion, with 48% of respondents indicating it was "not done" and rating it as the least important. This may suggest that while certifications have marketing value, they are not perceived as a key operational priority.

Figure 1. Degree of Use and Importance of Environmental Criteria



Source: Authors

Table 4 details the importance of these criteria segmented by SME size, age, and sector. Medium-sized companies assign greater importance to environmental criteria, particularly waste/water management and certifications. As companies mature, their emphasis on environmental criteria also increases, with waste management showing the largest difference. By sector, industrial firms place the highest value on environmental criteria, especially waste and water management, whereas the service sector shows lower perceived relevance for certifications.

Table 4. *Degree of importance of environmental criteria*

Degree of importance of environmental criteria	1. Size				2. Age			3. Sector				
Criterial	Micro	Small	Medium	Sig.	Young	Mature	Sig.	Industry	Construction	Commerce	Services	Sig.
Selection of suppliers	3,58	3,49	3,96	***	3,64	3,65	-	3,72	3,7	3,65	3,34	**
Management of plastic packaging and derivatives	3,72	3,58	4	***	3,75	3,75	**	3,89	3,78	3,87	3,35	***
Process design	3,64	3,52	3,93	***	3,67	3,68	-	3,78	3,74	3,85	3,24	***

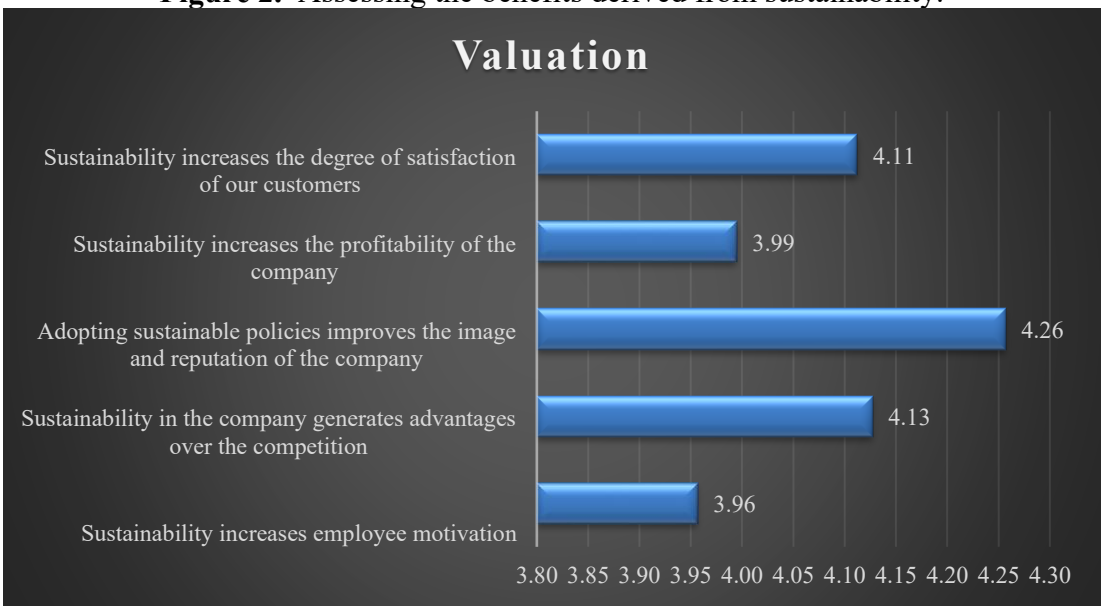
Energy management	3,62	3,53	3,94	***	3,64	3,69	*	3,64	3,69	3,78	3,31	***
Water management	3,84	3,67	4,12	***	3,83	3,88	**	3,97	3,87	3,93	3,54	**
Environmental criteria in waste management	3,89	3,87	4,18	***	3,89	4,04	***	4	4,01	4,07	3,64	***
Environmental certifications-ISO14001 / EMAS-	3,42	3,48	4,1	***	3,59	3,68	-	3,74	3,7	3,66	3,17	***
On a scale from 1 = Not at all important to 5 = Very important.												
Statistically significant differences: (*): p<0.1; (**): p<0.05; (***): p<0.01; - not significant.												

Source: Authors.

4.2. Benefits Derived from Sustainability

Figure 2 illustrates the perceived benefits of adopting sustainability measures. All criteria scored above 3.5, indicating a strong consensus on the strategic value of sustainable policies. Improving the company's image and reputation received the highest score (4.26), supporting the idea that sustainability is a powerful public relations tool. Gaining competitive advantages (4.13) and enhancing customer satisfaction (4.11) were also highly rated. While increasing employee motivation (3.96) and profitability (3.99) were rated slightly lower, they still received high scores.

Figure 2. Assessing the benefits derived from sustainability.



Source: Authors.

Table 5 shows that medium-sized and mature companies tend to recognize these benefits more strongly than their smaller and younger counterparts. Across sectors, firms in industry, construction,

and commerce assigned greater importance to sustainability's advantages compared to service-sector firms

Table 5. Degree of agreement with the benefits derived from sustainability.

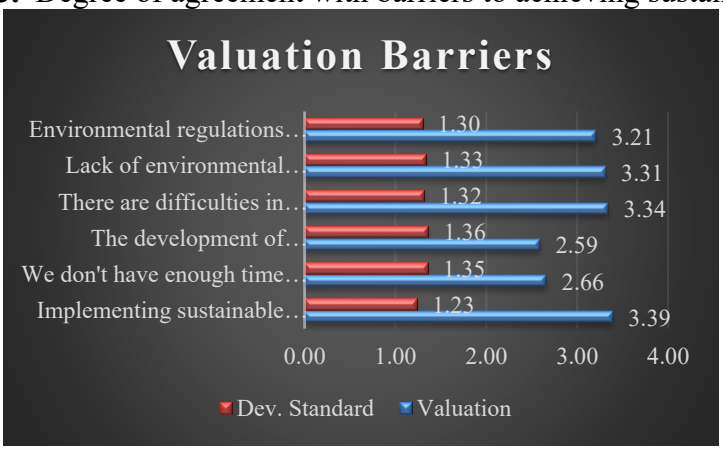
The sustainability of the SME	Size				Age			Sector				
	Micro	Small	Medium	Sig.	Young	Mature	Sig.	Industry	Construction	Commerce	Services	Sig.
Increasing employee motivation	3,91	3,87	4,21	***	3,91	4,03	***	4	4,02	4,09	3,71	***
Generating advantages over the competition	4,08	4,04	4,39	***	4,07	4,21	***	4,2	4,15	4,26	3,92	***
Improves the image and reputation of the company	4,23	4,17	4,45	***	4,21	4,33	***	4,31	4,27	4,4	4,06	***
Increasing the profitability	3,95	3,91	4,25	***	3,97	4,03	***	4,11	4,01	4,11	3,68	***
Increase Customer satisfaction	4,09	4,02	4,32	***	4,08	4,17	**	4,17	4,12	4,24	3,94	**
On a scale from 1 = Not at all important to 5 = Very important.												
Statistically significant differences: (*): p<0.1; (**): p<0.05; (***): p<0.01; - not significant.												

- Source: Authors.

4.3. Barriers to Sustainability

Figure 3 analyzes the perceived barriers to implementing sustainability. The cost of implementation ("is too expensive") was seen as the biggest hurdle, with a mean rating of 3.39. In contrast, lack of time (2.66) and potential loss of competitiveness (2.59) were considered the least significant obstacles. Difficulties in financing projects, lack of environmental training, and the complexity of regulations were perceived as moderately significant barriers.

Figure 3. Degree of agreement with barriers to achieving sustainability.



Source: Authors.

Table 6 shows that micro-enterprises perceive greater obstacles, particularly related to cost, financing, and lack of training. Young companies also reported greater difficulties with lack of time and financing compared to mature firms. By sector, construction companies perceived implementation as more expensive, while service companies were more concerned about the lack of training and regulatory complexity.

Table 6. Degree of agreement with the barriers to achieving SME sustainability

Barriers to sustainability	Size				Age			Sector				
	Micro	Small	Medium	Sig.	Young	Mature	Sig.	Industry	Construction	Commerce	Services	Sig.
Implementing sustainable development is too costly for the company	3,42	3,39	3,33	-	3,42	3,35	-	3,38	3,47	3,25	3,38	**
We don't have enough time to worry about social and environmental issues	2,68	2,63	2,64	***	2,69	2,61	**	2,62	2,69	2,41	2,7	***
The development of sustainability actions can cause us a loss of	2,55	2,61	2,68	***	2,63	2,53	-	2,78	2,57	2,53	2,55	*

competitiveness												
There are difficulties in financing projects related to sustainability	3,48	3,32	3,02	***	3,39	3,27	**	3,28	3,38	3,25	3,37	-
Lack of environmental training of company personnel	3,36	3,28	3,25	***	3,32	3,29	-	3,28	3,34	3,15	3,42	-
Environmental regulations are complex to apply	3,28	3,2	3,03	***	3,22	3,2	-	3,27	3,24	3,11	3,3	-
On a scale from 1 = Not at all important to 5 = Very important.												
Statistically significant differences: (*): p<0.1; (**): p<0.05; (***): p<0.01; - not significant.												

Source: Author's elaboration.

4.4. Correlation Between Study Variables

Descriptive statistics (Table 7) show that the 'Attitude' variable had the highest mean (4.15), while 'Knowledge' of barriers had the lowest (3.08).

Table 7. Descriptive statistics of the results.

	Average	Stand. deviation	N
Behaviour	3,6811	1,12719	3233
Attitude	4,1478	,87941	3233
Knowledge	3,0769	,96682	3233
Organizational_Performance	3,9889	,72442	3233

Source: Author's elaboration.

Correlation analysis (Table 8) tested the study's hypotheses.

- **H1:** A moderately positive and highly significant correlation was found between **Behavior** and **Organizational Performance** ($r = 0.338$, $p < 0.001$), supporting Hypothesis 1.
- **H2:** A moderately positive and highly significant correlation was found between **Attitude** and **Organizational Performance** ($r = 0.326$, $p < 0.001$), supporting Hypothesis 2.
- **H3:** A very weak but significant correlation was found between **Knowledge** (of barriers) and **Organizational Performance** ($r = 0.035$, $p < 0.05$). The weakness of this correlation leads to the rejection of Hypothesis 3.

These results suggest that proactive environmental behaviors and positive attitudes toward sustainability are associated with better organizational performance, whereas mere knowledge of barriers does not have a meaningful relationship with performance.

Table 8. Correlations between study variables.

Control variables			Behaviour	Attitude	Knowledge	Organizational Performance
*	Behaviour	Correlation	1,000	,461	,041	,338
		gl	0	3231	3231	3231
	Attitude	Correlation	,461	1,000	,054	,326
		gl	3231	0	3231	3231
	Knowledge	Correlation	,041	,054	1,000	,035
		gl	3231	3231	0	3231
	Organizational Performance	Correlation	,338	,326	,035	1,000
		gl	3231	3231	3231	0
Organizational_Performance: Comprises four primary dimensions: Financial Performance, Operational Efficiency, Employee Performance, and Customer Satisfaction.	Behaviour	Correlation	1,000	,394	,031	
		gl	0	3230	3230	
	Attitude	Correlation	,394	1,000	,045	
		gl	3230	0	3230	
	Knowledge	Correlation	,031	,045	1,000	
		gl	3230	3230	0	
* Corresponds to zero-order correlations (Pearson).						

- Source: Authors.

4.5. Neural Network Analysis

The Neural Network analysis (Table 9) reveals the relative importance of behavior, attitude, and knowledge for organizational performance across different contexts. This technique is particularly useful for capturing complex, non-linear relationships that traditional regression models might miss. For example, in the

manufacturing sector, **Behavior** (100%) is the most important variable, followed by Knowledge (72.3%) and Attitude (53.2%). In contrast, in the

service sector, **Knowledge** (100%) becomes the most important predictor, followed closely by Behavior (99.8%). For

micro-enterprises, **Behavior** (100%) is most relevant, whereas for **medium-sized enterprises**, **Attitude** (100%) is the dominant factor. This highlights that the drivers of performance related to sustainability are not universal but are highly contingent on the specific context of the firm.

Table 9. Importance of variables: Behavior, attitude, and knowledge of Organizational Performance.

Variable	Importancia	Importancia normalizada	Importancia	Importancia normalizada	Importancia	Importancia normalizada
Behaviour	0,443	100,0%	0,401	95,8%	0,388	99,8%
Attitude	0,236	53,2%	0,419	100,0%	0,222	57,2%
Knowledge	0,320	72,3%	0,179	42,8%	0,389	100,0%
	a. Sector = Manufacturers		*a. Sector = Commerce*		*a. Sector = Services*	
Behaviour	0,490	100,0%	0,356	94,0%	0,347	89,6%
Attitude	0,210	42,9%	0,266	70,2%	0,387	100,0%
Knowledge	0,300	61,2%	0,379	100,0%	0,265	68,5%
	a. Size = Micro Enterprise		*a. Size = Small enterprise*		*a. Size = Medium Enterprise*	
Behaviour	0,251	61,7%	0,307	71,6%		
Attitude	0,407	100,0%	0,429	100,0%		
Knowledge	0,342	83,9%	0,264	61,5%		
	a. Age = Young		*a. Age = Mature*			

Source: Author's elaboration.

5. Discussion

This study reveals a clear prioritization among SMEs toward environmental criteria with tangible operational impacts, such as waste and water management, which aligns with prior research indicating that firms often focus on motivations related to internal processes and stakeholder demands. The low priority given to supply chain criteria and formal certifications like ISO14001 suggest that SMEs may favor actions with direct environmental and cost-saving outcomes over those perceived as primarily administrative or reputational.

The findings strongly confirm that SMEs widely recognize the strategic benefits of sustainability. The perception that sustainable practices enhance corporate image, reputation, and competitive advantage is consistent with literature linking environmental performance to market positioning. However, our study adds nuance by showing that medium-sized and mature firms perceive these benefits more acutely, suggesting that as firms grow, they may become more attuned to the strategic value of sustainability.

Regarding barriers, the high perceived cost of implementation is a consistent finding in literature. Our results further show that these financial concerns are most pronounced in micro and young enterprises, highlighting their vulnerability and need for targeted support.

The correlation analysis provides one of the most compelling insights of this study. The positive association between both

behavior and **attitude** with organizational performance confirms that what firms *do* and what they *believe* about sustainability are linked to success. However, the negligible correlation between

knowledge of barriers and performance is particularly noteworthy. This suggests a significant "knowledge-action gap," a well-documented phenomenon where awareness of a problem does not automatically translate into corrective action. SMEs may be aware of the financial and regulatory hurdles, but this awareness alone does not drive performance; rather, proactive behaviors and a positive strategic attitude do. This finding challenges the assumption that simply educating firms

about barriers is sufficient to promote sustainability. Instead, interventions should focus on fostering positive attitudes and enabling concrete actions.

=6. Conclusion

SMEs are a crucial engine for socioeconomic progress in Colombia and are vital for achieving the SDGs. This study examined how Colombian SMEs integrate environmental sustainability principles, analyzing the roles of behavior, attitude, and knowledge. The results indicate that SMEs are strategically using sustainability to differentiate themselves, particularly through actions related to SDG 12 (Responsible Consumption and Production).

The findings have several practical implications. First, there is significant scope for smaller, younger, and service-sector firms to intensify their sustainability efforts to gain competitive advantages. Second, mature and industrial firms can serve as benchmarks, sharing best practices to help other SMEs realize the benefits of sustainability. Third, policymakers should design targeted support programs that address the specific barriers faced by different types of firms, moving beyond simple awareness campaigns to provide tangible financial and technical assistance that enables action.

In summary, this research underscores that a firm's environmental behavior and attitude are significantly associated with its organizational performance. Knowledge of barriers, while present, does not appear to be a critical factor in driving success. Therefore, to enhance corporate performance, companies and policymakers should focus on promoting positive behaviors and attitudes toward sustainability, supported by strategies that translate intent into meaningful environmental action.

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