

Evidence of the relationship between environmental management, organizational learning and performance

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Edited by:

Ana Paula Capuano da Cruz

Abstract

Objective: To investigate the mediating effects of the environmental management system and organizational learning on the relationship between environmental management accounting practices and operational, environmental, and financial performance.

Method: A descriptive survey with a quantitative approach was conducted with 121 controllers from industrial organizations established in Brazil.

Results: The results show that the adoption of environmental management accounting practices supports the structuring of the environmental management system. However, they do not have a direct and positive impact on organizational learning, which is enhanced when an environmental management system is structured. The effects of adopting such practices on performance are also different, directly impacting only environmental and financial performance. The adoption of such a management system also has no direct impact on performance, but indirectly, mediated by organizational learning, which is the only variable that explains the improvement in the operational performance of the companies studied.

Contributions: These results reveal important contributions to the field of study. They indicate that adopting isolated practices may not be enough to support improvements in organizational performance. Likewise, the structure of an environmental management system may not be enough for this to happen. It is necessary to learn and be able to improve the management processes established in the organization, so that problems can be corrected, improvements promoted, and operational efficiency improved.

Keywords: Environmental management accounting practices; environmental management systems; organizational learning; performance; industrial organizations.

How to Cite:

Zonatto, C. F., Degenhart, L., Fagundes, C. S. da S. C., & Fagundes, E. C. (2025). Evidências da relação entre gestão ambiental, aprendizagem organizacional e desempenho. *Advances in Scientific and Applied Accounting*, 18(1), 076–090/091. <https://doi.org/10.14392/asaa.2025180104>

Submitted: 22 August 2024
Revisions required on: 03 March 2025
Accepted: 15 April 2025

Introduction

The growing appreciation of environmental management as an essential element for the long-term success of organizations has been widely recognized (Appio et al., 2018; Sari et al., 2021). As pointed out by Ghasemi et al. (2019), a growing number of companies are adopting social responsibility practices, seeking not only to make a profit, but also to become organizations committed to the collective good. However, there are differing opinions, highlighting the natural tendency to prioritize economic performance over environmental management, as companies aim for profits for shareholders (Song et al., 2017).

The interest of society, governments and organizations in sustainability is on the rise (Adloff & Neckel, 2019; Sari et al., 2021). In the Brazilian context, the chemical industry plays a significant role, ranking third in industrial Gross Domestic Product (GDP) in 2018 and sixth in global net sales in the same year (Silva et al., 2022). The NBR ISO 14001 standard provides an approach to implementing environmental management systems, allowing organizations to follow a roadmap to effectively structure their systems, balancing socio-economic considerations with environmental requirements (Grotta et al., 2020). However, some organizations have found it difficult to reconcile the adoption of such practices and promote their performance (Degenhart et al., 2024).

Organizational learning within the environmental management system is one of the factors that can influence the success of the actions implemented. This is because it is not enough to produce information in order to evaluate and define the best alternative responses to the organizational problems identified, but to properly understand how to carry out these interventions to obtain the expected results. Zago (2016) notes that the adoption of different practices can impact performance in different ways, suggesting that environmental management practices can also affect financial performance, but not necessarily environmental performance, which can be explained by other factors, as proposed in this research, by analyzing the mediating effects of the environmental management system and organizational learning.

Many companies are adopting environmental management accounting practices and an environmental management system to improve their environmental performance (Phan et al., 2018; Fuzi et al., 2020; Sari et al., 2021). However, given their different effects on different performance metrics (operational, environmental and financial) (Zago, 2016), it is also necessary to understand how the adoption of such practices reflects on other organizational aspects, such as the structuring of the environmental management system and the learning capacity of companies, and how these factors influence this relationship.

Against this backdrop, the main objective of this research is to answer the following question: What are the mediating effects of the environmental management system and organizational learning on the relationship between environmental management accounting practices and operational, environmental, and financial performance?

The research innovates and advances in the analysis of such relationships, by incorporating into the proposed analysis the impacts of the environmental management system and organizational learning on the relationship between environmental management accounting practices and operational, environmental, and financial performance (Degenhart et al., 2024). Previous research on the subject has focused on evaluating a specific performance. However, in environmental matters, this approach is fragmented, and needs to be looked at from different perspectives of analysis, so that we can understand how the adoption of such practices reflects on performance (Zago, 2016; Degenhart et al., 2024), whether at an operational, environmental or financial level.

The effectiveness of these practices is influenced by organizational factors, such as organizational learning (Al-Adaileh, 2020). For this reason, observing this capacity can reveal under what conditions performance occurs and is positively impacted. As Schreyögg and Steinmann (1987) point out, management control systems perform two fundamental functions: strategic control and management control. Strategic control, aimed at the external environment, seeks to guide organizational plans, classify activities, guide the vision of senior management and motivate directors (Shao, 2019). On the other hand, managerial control focuses on the internal environment, designed to influence employees to direct their efforts towards organizational goals (Van Triest et al., 2023).

Therefore, it is possible to admit that these interactions can reflect distinctly on these three types of organizational performance, which provides an explanation for the conflicting results found on the subject (Zago, 2016). The findings of this research, in addition to contributing to the promotion of new knowledge, also reveal to managers and organizations how the adoption of a set of environmental management accounting practices can be incorporated, in order to structure and enhance the environmental management system and promote organizational learning, consequently reflecting in better performance (Gunarathne et al., 2021; Kong et al., 2022; Bresciani et al., 2022).

2 Theoretical bases

The growing recognition of the importance of balancing economic activities and environmental preservation is reflected in the increase in regulatory frameworks and pressure from stakeholders. Companies react responsively, influenced by competitors, customers, communities and legislators, seeking cost efficiency, long-term thinking and reputation management linked to environmental issues (Banerjee, 2001). Highly polluting companies increase green investment to relieve the pressure of public environmental concern, which also makes corporate management more focused on environmental responsibility (Gu et al., 2021).

Corporate performance begins at the individual level (Mahama & Cheng, 2013; Lunardi et al., 2020), where individual actions are shaped by the structure and processes of the management control system, through goals, changes in reference and changes in individual beliefs. Sustainable companies show greater resilience during crises, indicating that environmental practices contribute to adapting to challenges (De Almeida et al., 2024). The effective management of natural resources is considered crucial for professional and business performance, gaining competitive advantage and the effective implementation of social responsibility practices (Beuren & Zonatto, 2015; De Almeida et al., 2024).

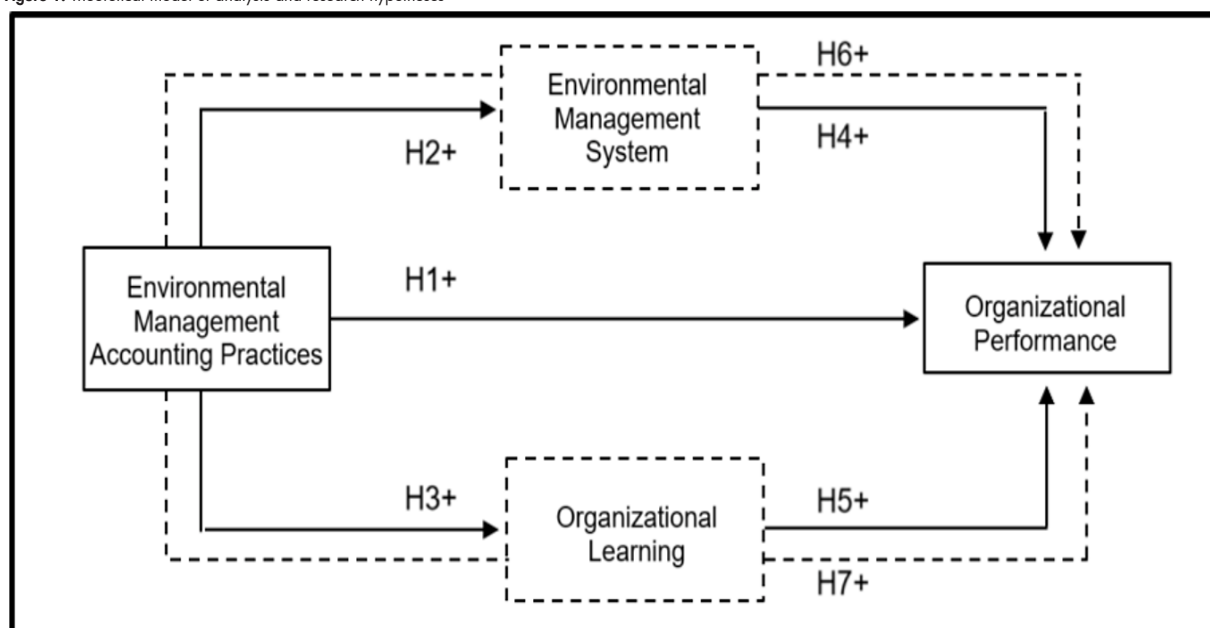
Managing sustainability involves acquiring new capabilities, managing resources efficiently and adopting sustainable practices (De Almeida et al., 2024). Environmental strategies evolve from an initial passive stance to proactive approaches, highlighting three levels of corporate envi-

ronmental awareness (Seiffert, 2007). The relationship between organizational learning and performance is complex and influenced by internal and external factors (Ghasemi et al., 2019), requiring further studies to better understand the conditions under which the management control system results in better performance.

The environmental impacts of organizational activities occur in various ways and also reflect on corporate reputation, which can result in a source of competitive advantage (Kalyar et al., 2019). This occurs when strategic management for sustainability seeks to create long-term value, managing economic, environmental and social opportunities and risks, and reflecting positively on company performance (Degenhart et al., 2024). It is therefore necessary to carry out new studies that seek to broaden the understanding of how the effects of adopting environmental management practices on performance occur (Zago, 2016; Degenhart et al., 2024), whether directly (Zago, 2016) or indirectly, mediated by other intervening variables (Degenhart et al., 2024), as investigated in this research.

It is understood that aspects such as the quality of the environmental management system adopted and the capacity for organizational learning are factors that can explain the indirect effects of adopting environmental management accounting practices on operational, environmental and financial performance. Figure 1 shows the summary of the proposed analysis, as defined by the theoretical analysis model established for the research.

Figure 1. Theoretical model of analysis and research hypotheses



Source: Elaborated by the authors.

It is based on the premise that implementing environmental management systems not only improves the efficient allocation of resources, but also boosts financial results, promotes continuous improvement, and strengthens relations with regulatory bodies (Wong et al., 2020). However, it is important to consider that an above-average comprehensiveness of the environmental management system can result in lower financial performance, which can correspond to high environmental management costs and overheads (Voinea et al., 2020). On the other hand, organizational learning is crucial for organizational performance, positively impacting individual and collective results (Argote et al., 2020).

Thus, in addition to analyzing the direct effects of adopting such management practices on performance (H1), it is possible to evaluate the effects of such management practices on promoting the environmental management system (H2) and organizational learning (H3). It is also possible to investigate how these factors affect performance (H4 and H5). Finally, assuming that these factors can explain under what conditions the adoption of environmental management accounting practices can have a positive impact on the performances analyzed, the mediating effects of the environmental management system (H6) and organizational learning (H7) in this relationship are investigated.

2.1 Environmental Management Practices and Business Performance

The search for a balance between economic activities and environmental preservation is growing, reflected in increased regulatory frameworks and pressure from stakeholders (Duan et al., 2024). Companies respond to these pressures reactively, influenced by competitors, customers, communities and legislators, aiming for cost efficiency, long-term thinking and reputation management (Beuren & Santos, 2019). When this happens, the pressures tend to be reduced, since the perception is that the organization cares about the environment and acts responsibly to exploit it while protecting it.

Faced with these pressures, companies tend to adopt a reactive stance, focusing on cost efficiency, long-term planning and reputation management (Beuren & Santos, 2019), since at the same time as they need to respond to existing institutional pressures, they need to generate profit. This dynamic is important because, in addition to complying with environmental regulations, it encourages companies to seek to stand out in a market that is increasingly aware of social and environmental issues.

Companies committed to sustainability have shown greater resilience during crises, highlighting that environmental practices contribute to prosperity and adaptation to challenges (Silva & Beuren, 2020). This occurs when these or-

ganizations are aware of the events that occur and impact their operations and are better prepared to respond to them (Degenhart et al., 2024). Therefore, strategic management for sustainability, focused on corrective and preventive actions and the efficient use of resources, seeks to create long-term value for products, services and corporations (Silva & Beuren 2020).

To do this, managers need to develop new capabilities, identify opportunities and adopt sustainable initiatives (Coyte, 2019). The assessment of organizational commitment (from a sustainable perspective) includes indicators such as environmental policy, managerial responsibility, code of conduct, implementation of environmental management systems, and training programs, and is essential for organizational transformation towards sustainability (Silva & Costa, 2022). These actions are beneficial to the organization and act to promote its performance.

For this reason, it follows that the adoption of environmental management accounting practices tends to positively influence organizational performance (Phan et al., 2018; Fuzi et al., 2020; Sari et al., 2021; Degenhart et al., 2024), which allows us to formulate the first research hypothesis: *H1. Environmental management accounting practices have a positive impact on operational performance (H1a), environmental performance (H1b) and financial performance (H1c).*

2.2 Environmental Management Practices, Environmental Management Systems and Organizational Learning

The environmental issue is widely debated in national and international contexts, recognized as a fundamental concern in business management (Brooks & Schopoll, 2021). Challenges such as the degradation of natural resources, global warming and the emission of harmful gases are intensifying rapidly and have a direct link with development, since companies take resources from the environment to produce goods and services (Calado, 2007; Dias, 2008).

Consumer awareness of the environmental impact of products has influenced their purchasing decisions, leading companies to adopt environmental programs to build a sustainable image (Franco et al., 2010). Implementing an environmental management system works to this end, and requires preparing employees, fostering organizational learning and adopting practices in line with progress (Ascani et al., 2021). It is the management practices adopted that support the structuring of an adequate environmental management system (Degenhart et al., 2024).

Fuzi et al. (2020) explain that this is a requirement for the success of the environmental management system adopted. This is because through the joint use of environmental management accounting practices and an environmental management system, it is possible to promote more assertive

decision-making, helping to achieve better organizational performance (Fuzi et al., 2020; Degenhart et al., 2024). Thus, the second hypothesis investigated in this research establishes that: *H2. Environmental management accounting practices have a positive impact on the environmental management system.*

In theoretical and conceptual terms, environmental management is described as a set of strategies, principles and procedures for preserving the integrity of the physical and biological environments (Cury, 2002). Environmental management systems encompass elements such as organizational structure, planning, responsibilities and practices to minimize the negative effects of business activities on the environment (Brooks & Schopoll, 2021; Gunarathne et al., 2021). Therefore, they support management processes and act to promote reflection and organizational learning, since they aim to improve the entity's management processes in the quest to achieve better performance.

Environmental practices are recognized as part of companies' social responsibilities, becoming strategic for various aspects, including competitiveness, marketing, finance, and product development (Appiah-Kubi & Annan, 2020). For these reasons, managerial control is developed to promote the high involvement of individuals at work, incorporating characteristics such as participatory decision-making and the use of individual skills, maximizing the quality of task performance (Mahama & Cheng, 2013; Lunardi et al., 2020), internal processes and the performance of the organization (Fuzi et al., 2020; Sari et al., 2021; Degenhart et al., 2024).

The effective integration of environmental practices into business operations (Fuzi et al., 2020), coupled with the use of environmental management systems (Degenhart et al., 2024), becomes crucial for companies seeking not only to meet regulatory standards, but also to build a positive sustainable image (Franco et al., 2010), improving their reputation (Agnihotri et al., 2022) and the management processes put in place, as well as their financial performance (Zago, 2016).

For these reasons, environmental management, including the implementation of environmental management systems, emerges as an essential management tool, but its effectiveness depends on the continuous monitoring of environmental performance indicators (Carini et al., 2021), and the organization's learning capacity to promote the necessary improvement actions. Thus, the third hypothesis investigated in this research establishes that: *H3. Environmental management accounting practices have a positive impact on organizational learning.*

2.3 Environmental Management Systems, Organizational Learning and Business Performance

Environmental effects arise from business activities linked to the environment, and environmental management systems, as proposed by the ISO 14001 standard, provide a framework for continuous improvement, although their application does not automatically guarantee the immediate reduction of negative impacts (Harland et al., 2021). The requirements of the ISO 14001 standard are organized into general requirements, environmental policy, planning, implementation and operation, verification and corrective action, as well as guidelines for using the standard (Silva & Costa, 2022).

Environmental policy requires an appropriate policy for activities, products and services, commitment to continuous improvement, pollution prevention, compliance with environmental legislation and standards, establishing the framework for environmental objectives and targets (Taschner & Charifzadeh, 2020). Planning covers various aspects, including reducing adverse impacts, developing procedures for assessing environmental performance, designing products to minimize impacts, preventing pollution, reducing waste, decreasing resource consumption, committing to recovery and recycling, education and training, engaging stakeholders, and striving towards sustainable development (Ahmed et al., 2019).

Implementation and operation establish criteria for setting up the system, such as defining and documenting structure and responsibilities, providing essential resources, identifying training needs, staff competence, procedures for internal and external communication, document control, identifying relevant operations, planning activities, documenting and communicating operating procedures, as well as procedures for document control and preventing environmental impacts (Silva & Beuren, 2020).

Corrective action establishes criteria for the periodic monitoring of operations and activities, including the regular assessment of compliance with environmental legislation, record keeping, treatment of non-conformities, procedures for corrective and preventive actions, conducting periodic audits of the environmental management system (Voorberg et al., 2021). The integration of these systems has the potential for mutual benefits, contributing to sustainable development and complying with specific standards (Pereira et al., 2013; Beuren & Zonatto, 2015).

The existence of companies with certified quality management systems encourages the consideration of integrated environmental and occupational health management systems (Dias, 2003). The integration of management systems, such as quality, environment and occupational health, is an approach adopted by organizations to avoid duplication of effort and minimize administrative difficulties (Hamilton & Sodeman, 2020). This integration can include, depending on the specific needs of each company, quality,

environmental management and occupational health and safety processes (Agnihotri et al., 2022).

Therefore, it can be inferred that the structuring and implementation of an environmental management system is carried out to promote improvements in organizational performance, which allows us to formulate the fourth hypothesis investigated in this research: *H4. The environmental management system has a positive impact on operational performance (H4a), environmental performance (H4b) and financial performance (H4c).*

It is important to note that the ISO 14001 standard, by providing an internationally valid guide for environmental certification, motivates companies to adopt environmental management systems (Pereira et al., 2013). The benefits include opening markets, improving management, satisfying customers, complying with legislation, standardizing internal procedures, reducing costs, improving the company's reputation, raising environmental awareness in the supply chain and developing clean production practices (Agnihotri et al., 2022).

However, achieving these benefits requires commitment from senior management, change management and monitoring of external, social, and technical aspects (Taschner & Charifzadeh, 2020). Likewise, it requires learning and intervention capacity, so that the proposed actions are effectively able to promote the necessary changes. It must also be considered that implementation faces challenges, such as the involvement of senior management, difficulties in interpreting procedures, especially related to human resources such as low education, lack of training, demotivation, and resistance to change (Agnihotri et al., 2022; Dhar et al., 2022).

Therefore, improving learning capacity is an important antecedent factor in achieving better organizational performance, since by promoting involvement and learning on the part of the actors who will lead the management processes and the development of organizational activities, it becomes possible to act with a view to achieving the desired organizational objectives. Thus, the fifth hypothesis to be tested in this research states that: *H5. Organizational learning has a positive impact on operational performance (H5a), environmental performance (H5b) and financial performance (H5c).*

2.4 Mediating Effects of Environmental Management Systems and Organizational Learning

Management control systems are defined as mechanisms and procedures that use information to maintain or modify the standards of a formalized activity in an organization (Henri, 2006; Hared et al., 2013). Conventional approaches to MCS often ignore environmental issues, although

there is a meaningful relationship between these concepts (Nishitani et al., 2022).

Recent studies have explored the relationship between MCS and environmental issues, investigating how environmental management systems influence financial performance and how environmental strategies can be integrated into MCS (Ascani et al., 2021). They also extend the analysis of such relationships by incorporating other performance metrics (environmental, financial, and operational) (Degenhart et al., 2024).

The growing appreciation of environmental management strategy as a determining factor in improving the environmental and economic performance of organizations has been recognized, with environmental management accounting being a mediating element in this relationship (Gunaratne et al., 2021). Therefore, it can be assumed that the adoption of such management practices tends to positively influence performance, either directly (Zago, 2016) or indirectly (Degenhart et al., 2024), through other intervening factors, as proposed in this research.

Environmental strategies, related to environmental objectives, describe how to achieve them (Rötzel et al., 2019; Fuzi et al., 2020). The comprehensiveness of these strategies in the MCS defines the consistency of information on priority environmental objectives (Asiaei et al., 2021). The structuring and use of environmental management systems serves this purpose (Fuzi et al., 2020). Through these systems, it becomes possible to define aspects established as priorities in environmental management, which need to be improved (Asiaei et al., 2021).

In this way, the adoption of such control structures provides guidance mechanisms for the organization (Fuzi et al., 2020), as they define the necessary guidelines to be observed for the management of environmental issues, which reflect on the performance of companies (Degenhart et al., 2024). In this context, the sixth research hypothesis states that: *H6. The environmental management system positively influences the relationship between environmental management accounting practices and operational (H6a), environmental (H6b) and financial performance (H6c).*

In addition to these aspects, the learning capacity of companies must also be considered. This is because organizational learning capacity enables the creation, transfer, integration and application of new knowledge, which is necessary to improve management practices and operational activities (Tohidi et al., 2012; Wojahn, Gomes & Zonatto, 2020), with a view to improving processes and organizational performance.

Organizations that manage to learn and improve their management practices and operational processes are

more likely to improve their performance (Lin & Wu, 2014). Based on this premise, the last hypothesis investigated in this study establishes that: *H7. Organizational learning positively influences the relationship between environmental management accounting practices and operational (H7a), environmental (H7b) and financial performance (H7c).*

3 Research Method and Procedures

This research adopts a descriptive approach, conducted through a survey and quantitative data processing, using structural equation modeling (SmartPLS®). The study focuses on industrial organizations established in Brazil. The choice of these organizations is because industrial organizations are susceptible to developing actions that generate a greater impact on the environment, and for this reason need to measure and respond to the environmental impacts generated (Sari et al., 2021).

The sample analyzed consisted of 121 controllers. Controllers are professionals who support the structuring of the management system and act to

promote the connection between senior management and the operational level (Degenhart et al., 2024). They therefore act directly in generating information that supports decision-making processes. Data collection took place between April and July 2022, and 600 invitations were distributed using the LinkedIn® networking platform. Of these, 420 invitations were accepted, resulting in 121 fully complete questionnaires, representing a response rate of 28.81%.

As part of the ethical procedures adopted, the participants in the survey were assured of the anonymity of their identities and those of their respective companies. Therefore, the answers obtained were collected based on the respondents' agreement to use the data to produce this work. The research construct sought to analyze the adoption of environmental management accounting practices, the environmental management system, organizational learning, and performance. Table 1 details the research constructs, their operational definitions, indicators, scales adopted, and the key authors of each tool used.

Table 1. Research constructs

Constructs	Operational definitions	Indicators/ Scale	Authors
Environmental management accounting practices	Methods and practices that organizations use to identify, assign and manage costs related to the environment in order to improve environmental performance and economic efficiency.	7 indicators 7-point Likert	Fuzi et al. (2020)
Environmental management system	It involves a structured set of policies and practices that enable an organization to manage its environmental impact and comply with regulatory requirements, as well as promoting continuous improvements in its environmental practices.	7 indicators 7-point Likert	Fuzi et al. (2020)
Organizational learning	An organization's ability to create competitive advantages through a learning mechanism based on executive experiences and the absorption of external information and resources.	7 indicators 7-point Likert	Lin e Wu (2014)
Operational Performance	Operational Performance	7 indicators 7-point Likert	Xue et al. (2019)
Environmental Performance	A company's ability to minimize negative impacts on the environment. This includes reducing pollutant emissions, managing waste and preventing environmental accidents.	7 indicators 7-point Likert	Xue et al. (2019)
Financial Performance	A company's ability to minimize negative impacts on the environment. This includes reducing pollutant emissions, managing waste and preventing environmental accidents.	7 indicators 7-point Likert	Xue et al. (2019)

Source: Prepared by the authors.

The data collected was tabulated in an electronic spreadsheet and then imported into SPSS® software (for descriptive data analysis: minimum, maximum, mean and standard deviation) and SmartPLS® for statistical treatment. The analysis procedures adopted complied with the recommendations of Hair Jr. et al. (2009), and the evaluation parameters indicated, observing, for the validation of the measurement constructs, the analysis of the Cronbach's Alpha, Composite Reliability and AVE coefficients, and, for the discriminant validity of the

structural model, the Fornell and Larcker (1981) criterion. Finally, to analyze the relationships investigated, statistical significance was assessed. The results are presented below.

3 Research Results

4.1 Validation of the Measurement Constructs

Table 2 shows the results of the descriptive analysis of the data and the validation of the measurement constructs.

Table 2. Descriptive statistics, discriminant validity and reliability

Variables	Interval Real	Average	Standard Deviation	Factorial Loadings	Cronbach's alpha	Reliability Compound	AVE						
Environmental Management Accounting Practices													
PEC	1.00 - 7.00	5.14	1.54	[0,643; 0,784]	0.769	0.844	0.521						
PER	1.00 - 7.00	4.18	1.77	[0,619; 0,826]	0.793	0.857	0.548						
PES	1.00 - 7.00	4.78	1.42	[0,624; 0,877]	0.874	0.911	0.674						
PMC	1.00 - 7.00	4.74	1.67	[0,643; 0,784]	0.914	0.936	0.748						
PCF	1.00 - 7.00	4.95	1.65	[0,749; 0,922]	0.899	0.931	0.773						
Environmental Management System													
EMSP	1.00 - 7.00	5.41	1.67	[0,771; 0,853]	0.862	0.900	0.644						
EMSI	1.00 - 7.00	4.70	1.76	[0,809; 0,845]	0.854	0.901	0.695						
EMSA	1.00 - 7.00	5.32	1.33	[0,648; 0,832]	0.806	0.866	0.566						
EMSC	1.00 - 7.00	4.96	1.58	[0,742; 0,873]	0.868	0.905	0.657						
Organizational Learning													
OL	1.00 - 7.00	4.93	1.61	[0,899; 0,934]	0.902	0.939	0.836						
Organizational Performance													
OP	1.00 - 7.00	3.98	1.84	[0,859; 0,926]	0.925	0.947	0.816						
EP	1.00 - 7.00	4.86	1.42	[0,933; 0,937]	0.928	0.954	0.873						
FP	1.00 - 7.00	4.77	1.63	[0,907; 0,942]	0.921	0.949	0.862						
Discriminant Validity (Fornell & Larcker, 1981)													
PCF	EMSP	EMSI	EMSA	EMSC	OL	EP	FP	OP	SGV	AO	DA	DF	DO
PEC	0.722												
PER	0.611	0.740											
PES	0.498	0.383	0.821										
PMC	0.503	0.396	0.361	0.865									
PCF	0.515	0.605	0.711	0.784	0.879								
EMSP	0.240	0.198	0.222	0.254	0.292	0.802							
EMSI	0.220	0.152	0.264	0.205	0.248	0.304	0.834						
EMSA	0.271	0.220	0.235	0.156	0.145	0.327	0.506	0.752					
EMSC	0.293	0.296	0.262	0.211	0.288	0.197	0.473	0.655	0.810				
OL	0.206	0.234	0.259	0.296	0.314	0.312	0.467	0.646	0.672	0.914			
EP	0.302	0.215	0.398	0.402	0.365	0.341	0.286	0.300	0.172	0.339	0.935		
FP	0.167	0.211	0.308	0.211	0.271	0.163	0.241	0.327	0.288	0.396	0.438	0.928	
OP	0.208	0.159	0.204	0.258	0.296	0.402	0.261	0.293	0.241	0.427	0.534	0.567	0.903

Legend: PEC. Practices related to Environmental Costs; PER. Practices related to Environmental Regulation; PES. Practices related to Environmental Safety; PMC. Practices related to Management Commitment; PCF. Practices related to Customer Focus; EMSP. Environmental Management System related to Planning; EMSI. Environmental Management System related to Implementation and Operation; EMSA. Environmental Management System related to Auditing and Evaluation; EMSC. Environmental Management System related to Corrective Action; OL. Organizational Learning; OP: Operational Performance; EP: Environmental Performance; FP: Financial Performance.

Source: Research data.

The results of the descriptive data analysis show that not all organizations adopt environmental management accounting practices. Of those that do, the main practices used are related to environmental cost management (PEC), environmental safety (PES) and the focus on meeting customer demands (PCF). These results reinforce the evidence found in the literature on the propensity of industrial organizations to adopt environmental management accounting practices in order to improve the efficiency of their operations (Appio et al., 2018; Sari et al., 2021), as well as their image in the eyes of customers (Kalyar et al., 2019).

The environmental management system is also fragmented, and not all organizations manage to structure it properly. Among those that do adopt it, its main application is related to planning activities (EMSP), auditing and evaluation (EMSA) and establishing actions and corrections (EMSC). Proper planning of activities provides better management of the resources used in the organization (De Almeida et al., 2024). Follow-up actions are necessary to ensure that the desired results are achieved, or to establish interventions and promote improvement actions, so that it is possible to achieve the expected results (Gunaratne et al., 2021; Kong et al., 2022; Bresciani et al., 2022).

The results shown in Table 2 also reveal worrying evidence in relation to the levels of organizational learning and performance identified in these companies. Organizational learning (OL) explains the success of some organizations in managing their activities. Organizations that manage to learn, correct, and improve their processes are more efficient. On the other hand, organizations that fail to establish such measures in their management practices tend to have difficulties in promoting sustainable competitive advantages, improving the efficiency of their operations, and achieving better performance (Tohidi et al., 2012; Wojahn, Gomes & Zonatto, 2020).

The performance analyzed reveals that most organizations have low operational (OP) and financial (FP) performance, although they also report greater effectiveness in their environmental management (EP). These findings corroborate the evidence found in the literature that performance is affected distinctly in these three perspectives of analysis, with not all organizations managing environmental management practices to improve their operational and financial results (Zago, 2016; Degenhart et al., 2024).

This evidence reinforces the importance of the analysis proposed in this research, so that we can better understand how the adoption of such management practices interacts with the environmental management system to promote organizational learning and improve performance. They provide an explanation for the low levels of organizational learning capacity identified in this research and the performance (operational, environmental, and financial) reported.

Regarding reliability indicators, the results of Cronbach's alpha and composite reliability are higher than the minimum values recommended by Hair Jr. et al. (2009) for validation (0.70), as are the results of the AVE (0.50). The structural model analyzed also has discriminant validity, since the value of the square root of the AVEs is higher than the values of the correlations between the constructs analyzed in the research (Fornell & Larcker, 1981). This makes it possible to analyze the proposed relationships using structural equation modeling.

4.2 Discussion of Results

Table 3 summarizes the results of the analysis of the theoretical relationships investigated in the research.

Table 3. Standardized coefficients and significance of the relationships in the structural models tested.

Hip.	Relationship	Coef. Padr.	Erro P.	T-values	P-values	Results
Direct effects						
H1a	EMAP→OP	0.144	0.089	1.616	0.107 ^{ns}	Supported
H1b	EMAP→EP	0.342	0.083	4.124	0.000*	Supported
H1c	EMAP→FP	0.173	0.080	2.160	0.031*	Supported
H2	EMAP→EMS	0.384	0.081	4.738	0.000*	Not sup.
H3	EMAP→OL	0.068	0.074	0.925	0.355 ^{ns}	Not sup.
H4a	EMS→OP	0.121	0.125	0.970	0.333 ^{ns}	Not sup.
H4b	EMS→EP	0.126	0.121	1.044	0.297 ^{ns}	Not sup.
H4c	EMS→FP	0.076	0.126	0.607	0.544 ^{ns}	Supported
H5a	OL→OP	0.292	0.106	2.756	0.006*	Not sup.
H5b	OL→EP	0.134	0.129	1.044	0.297 ^{ns}	Supported
H5c	OL→FP	0.284	0.125	2.267	0.024*	Supported
	EMS→OL	0.692	0.045	15.506	0.000*	Supportada
Efeitos Indiretos						
H6a	EMAP→EMS→OP	0.046	0.051	0.912	0.362 ^{ns}	Not sup.
H6b	EMAP→EMS→EP	0.049	0.050	0.967	0.334 ^{ns}	Not sup.
H6c	EMAP→EMS→FP	0.029	0.051	0.578	0.563 ^{ns}	Not sup.
H7a	EMAP→OL→OP	0.020	0.024	0.820	0.413 ^{ns}	Not sup.
H7b	EMAP→OL→EP	0.009	0.016	0.576	0.565 ^{ns}	Not sup.
H7c	EMAP→OL→FP	0.019	0.025	0.787	0.432 ^{ns}	Not sup.
	EMAP→EMS→OL	0.266	0.058	4.554	0.000*	Supported
	EMAP→EMS→OL→OP	0.078	0.033	2.342	0.020*	Supported
	EMAP→EMS→OL→EP	0.036	0.038	0.950	0.343 ^{ns}	Não Sup.
	EMAP→EMS→OL→FP	0.075	0.039	1.940	0.053**	Supportada
Quality indicators						
	EMS	Máx. VIF	R ²	Q ²	f ²	
	OL	2.172	0.148	0.049	0.287	
	EP	2.084	0.520	0.422	0.623	
	FP	2.172	0.239	0.196	0.695	
	OP	2.172	0.190	0.146	0.673	
		2.172	0.213	0.162	0.674	

Legend: EMAP. Environmental Management Accounting Practices; EMS. Environmental Management System; OL. Organizational Learning; OP. Operational Performance; EP. Environmental Performance; FP. Financial Performance.

Source: Research data.

The results show that environmental management accounting practices (EMAP) only have a direct and positive influence on environmental performance (EP) and financial performance (FP), which support hypotheses H1b and H1c. However, they are not directly reflected in operational performance (OP), which does not support H1a. These results show that organizations that adopt practices related to managing their environmental costs, environmental regulation, promoting environmental safety and acting with environmental commitment, and paying attention to the demands of their customers, are more likely to have high environmental and financial performance.

According to Duan et al. (2024), due to concern about environmental issues, organizations have structured themselves to promote more solid environmental management that is committed to stakeholder expectations. The response to these pressures (Beuren & Santos, 2019) has led organizations to adopt environmental management accounting practices (Phan et al., 2018; Fuzi et al., 2020; Sari et al., 2021; Degenhart et al., 2024), which are beneficial for achieving better performance and structuring an effective environmental management system (Degenhart et al., 2024).

These statements are corroborated by the evidence found in this research. The PCGA has a direct, positive, and significant influence on the structuring of the environmental management system (EMS), supporting H2, but not on organizational learning (OL), which does not support H3. The latter is only directly and positively impacted by the adoption and use of environmental management systems, which, when present, enhance companies' ability to learn.

These results reveal important implications for the field of study. They show that adopting environmental management practices alone does not ensure learning and improvement in the organization's operational management processes, which requires the ability to accurately diagnose existing problems, establish the best alternatives and solutions, and verify the aspects that can provide the desired results. From there, they start to act effectively so that the proposed solutions can result in the desired gains. This is a necessary condition for learning and achieving better operational performance.

As Coyte (2019) explains, managers need to be able to develop new capabilities so that they can identify opportunities for improvement and enable the adoption of sustainable initiatives. Environmental management systems (as proposed by ISO) act as a guide and provide guidance and direction for managers to accurately assess existing environmental issues (Ahmed et al., 2019; Taschner & Charifzadeh, 2020; Voorberg et al., 2021). Consequently, they may be able to act to promote the necessary changes (Hamilton & Sodeman, 2020; Agnihotri et al., 2022).

For this reason, promoting the development of

organizational learning capacity is important to effectively promote learning in companies (Tohidi et al., 2012; Wojahn, Gomes & Zonatto, 2020) and responsible social and environmental performance (Ghasemi et al., 2019). However, not all of them manage to do so (Song et al., 2017), which is why it is necessary to understand how such interactions explain the performances analyzed in the study.

With regard to the direct effects of EMS and OL on the performance analyzed, the results also revealed that the adoption of environmental management systems alone is not enough to improve operational (OP), environmental (EP) and financial (FP) performance, thus failing to support hypotheses H4a, H4b and H4c. Improving the learning capacity of organizations tends to have a direct and positive influence on operational (OP) and financial (FP) performance, supporting H5a and H5c, but not significantly on environmental performance (EP), H5b.

Regarding the mediating effects analyzed, both hypotheses H6 and H7 cannot be supported. This is because, in isolation, only the adoption and use of EMS (H6. $EMAP \rightarrow EMS \rightarrow PERF$) or the improvement in organizational learning capacity (H7. $EMAP \rightarrow OL \rightarrow PERF$) cannot positively influence the relationship between EMAP and performance. The results show that this only occurs when both conditions are present ($EMAP \rightarrow EMS \rightarrow OL \rightarrow PERF$), in which the company is able to effectively adopt and implement EMAP, structure and use an EMS, promote its learning capacity, and thus improve its performance, as seen in the analysis of the indirect effects identified in the mediation observed between: $EMAP \rightarrow EMS \rightarrow OL$; $EMAP \rightarrow EMS \rightarrow OL \rightarrow OP$; and, $EMAP \rightarrow EMS \rightarrow OL \rightarrow FP$, which occurs for EP.

These results reveal the complexity of organizational management processes, and the need to structure an appropriate management control system to establish competitive gains, considering the organizational reality. From a strategic perspective, it suggests that strategic organizational controls need to be structured to establish the clear definition and organization of plans and activities, in order to provide guidance to managers (Shao, 2019). On the other hand, at the operational level, it is necessary to converge and direct efforts so that the execution of activities (and their monitoring) takes place in accordance with the defined organizational plans (Van Triest et al., 2023). This makes it possible to achieve the expected results and defined objectives.

This is because, when execution takes place properly, it is possible to promote learning, the identification of viable solutions and alternatives and thus promote better performance. Therefore, it can be inferred that the adoption of such management practices tends to positively influence the levels of organizational learning and performance (Zago, 2016; Degenhart et al., 2024), since the definition of appropriate environmental management

strategies provides clarity of objectives and action plans that should be pursued, and how to achieve them (Rötzel et al., 2019; Fuzi et al., 2020), supporting managers in the development of their duties.

5 Final considerations

This study investigated the mediating effects of the environmental management system and organizational learning on the relationship between environmental management accounting practices and operational, environmental, and financial performance among 121 industrial organizations established in Brazil. The results revealed that the adoption of environmental management accounting practices supports the structuring of the environmental management system. However, they do not have a direct and positive impact on organizational learning, which is enhanced when an environmental management system is structured.

The effects of adopting such management practices on performance are also different, with only environmental and financial performance having a direct impact. The adoption of an environmental management system also has no direct impact on performance, but is indirectly mediated by organizational learning, which is the only variable that explains the improvement in the operational performance of the companies studied. The mediations investigated, in isolation, do not explain the improvement in organizational performance. This is observed from the analysis of the joint effects of these control instruments, which, by boosting the capacity for organizational learning, improve the operational and financial performance of the companies.

These results reveal important contributions to the field of study. They indicate that adopting isolated practices may not be enough to support improvements in organizational performance. Likewise, the structure of an environmental management system may not be enough for this to happen. It is necessary to learn and be able to improve the management processes established in the organization, so that problems can be corrected, improvements promoted, and operational efficiency improved.

Despite these findings, it was also possible to identify the difficulty some companies have in adopting environmental management accounting practices. In this case, it can be seen that these organizations have the greatest difficulty in managing their environmental costs, promoting environmental regulation, environmental safety, commitment to environmental management and acting in line with customer expectations and needs. A probable explanation for these results may be related to the difficulties encountered by these companies in

promoting environmental and operational performance without influencing their financial performance (Song et al., 2017).

Environmental management requires investment and the application of resources to obtain adequate information for the improvements that are needed. Likewise, the interventions to be established require choices, ranging from the definition of an appropriate environmental management strategy (Seiffert, 2007), to the definition of policies, plans, objectives and the application of resources (Rötzel et al., 2019; Fuzi et al., 2020; Asiaei et al., 2021). Therefore, environmental management tends to impact organizational activities in different ways, interfering not only in corporate reputation, but in the competitive condition of companies and their performance (Kalyar et al., 2019; Degenhart et al., 2024).

It was also found that some organizations have difficulties implementing environmental management systems. As a result, they are unable to promote their learning capacity and operational performance. The low levels of organizational learning identified in this research also require attention. They reveal that some organizations have been preoccupied with developing their activities to the detriment of environmental issues. As a result, they waste resources, are inefficient and tend to have difficulties managing their environmental costs and resources, which tend to negatively influence their performance. The difficulty in promoting their learning capacity is another aggravating factor. This is because these organizations tend to repeat their mistakes, problems and inefficiencies, which results in a loss of competitiveness and poor performance.

The results of this research reveal important contributions to literature and to organizational practice. They highlight the growing appreciation of environmental management as an essential component for the long-term success of organizations. They show that the adoption of environmental management accounting practices and the implementation of environmental management systems demonstrate companies' commitment to the collective good and sustainability. Likewise, they act to promote companies' learning capacity and performance, which mitigates problems related to waste, excess waste and problems that result in high environmental damage.

To this end, they reveal that organizational commitment is necessary for this to happen, as well as investments, the definition of objectives, plans and action strategies that guide and support the development of companies' activities. Organizational learning emerges as a crucial factor influencing the effectiveness of environmental management practices. The way organizations implement and adapt their practices can affect both financial and

environmental performance. Therefore, investing in organizational learning programs can improve the operational and financial efficiency and effectiveness of the environmental management initiatives developed in companies. The results also suggest that integration between the different aspects of environmental and organizational management is essential for achieving sustainable performance.

These findings also stimulate further studies on the subject. The relationship between environmental management accounting practices, the environmental management system, organizational learning, and organizational performance shows the complexity and interdependence of these elements. They also reveal that some companies have difficulties in managing them. Therefore, understanding the factors that influence the adoption of such management practices, and the structuring of a management control system is an important research opportunity on the subject.

Investigating the predictors of organizational learning in the field of environmental management is also a relevant research opportunity, as is the analysis of other organizational capabilities (such as absorptive capacity and innovation). In addition, including new analytical components in these relationships could provide new research into the predictors of environmental, operational, and financial performance, an important theoretical gap on the subject. These questions constitute important research opportunities.

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