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Applying Structural Equation Modelling to Examine the Impact of Environmental Management Accounting on Financial

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Abstract

Environmental management accounting has garnered significant attention from various stakeholders. Enterprises that effectively implement environmental management accounting not only contribute to sustainable development but also enhance organizational performance. This study aims to examine the relationship between environmental management accounting, green innovation, and the financial performance of small and medium-sized enterprises in the context of a developing country like Vietnam. A quantitative research approach was employed to analyze data collected through a structured survey. The dataset comprises responses from 151 small and medium-sized enterprises, with financial managers and management accountants serving as key informants. Data analysis was conducted using the Smart Partial Least Squares software. The findings reveal that environmental management accounting has a direct positive impact on financial performance and an indirect impact through the mediation of green process innovation. While green product innovation exerts a direct impact on financial performance, environmental management accounting appears to have no significant influence on green product innovation. Consequently, green product innovation does not function as a mediating variable in the relationship between environmental management accounting and financial performance. The results underscore the greater significance of green process innovation over green product innovation in driving improvements in the financial performance of small and medium-sized enterprises. These results significantly contribute to the relatively unexplored theoretical relationship between environmental management accounting, green innovation, and the financial performance of small and medium-sized enterprises. Furthermore, the study provides a practical foundation for managers to boost their organizations' financial performance by practicing environmental accounting and integrating green innovation into business operations.

Keywords: Accounting Environment, Green, Innovation, Performance, Medium-Sized Enterprises

1. Introduction

Environmental protection has become a pressing global issue in the context of rapid population growth and robust industrial development [1], [2], [3], [4]. Environmental degradation caused by climate change, pollution of resources such as land, water, and air, and excessive resource consumption has placed significant pressure on enterprises, requiring them to alter their management strategies and operations to mitigate negative environmental impacts [5], [6] [7], [8], [9]. To address these challenges, many scholars argue that integrating environmental strategies into corporate governance is not only a social responsibility but also a key driver of sustainable development.

Green innovation, a subset of innovation, has gained increasing attention. Although innovation may entail economic trade-offs, it is regarded as a primary approach to tackling environmental issues [10], [11]. Numerous researchers agree that innovation is a crucial factor in enhancing company performance. Consequently, many enterprises have prioritized addressing environmental challenges by fostering innovation, which not only improves organizational performance but also steers business practices toward sustainability. This approach ensures the organization's long-term benefits while fulfilling its responsibilities to stakeholders, including customers, partners, and shareholders. Despite the importance of innovation for organizational performance, theoretical and empirical studies on this relationship have yielded inconsistent results, necessitating further research for a comprehensive understanding [11]. Such inconsistency can be partly explained by the varied orientations in green innovation, specifically whether the focus lies on green process innovation or green product innovation. In Vietnam, these challenges are even more critical as the country grapples

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with the aftermath of industrialization and urbanization. This process causes harm to environmental issues and has garnered significant attention from various stakeholders. Therefore, placing emphasis on environmental concerns in all business activities has gradually become a critical practice. Many businesses have started adopting environmental management models, with EMA emerging as a valuable tool. EMA not only provides financial information related to environmental costs but also facilitates the assessment of the physical impact on resources [9], [11], [12]. It equips managers with information for planning, decision-making, and controlling environmental activities and impacts [9], [13]. The application of EMA enables businesses to control costs, enhance resource efficiency, and meet the demands of customers, investors, and regulators [8], [9].

Although the relationship between EMA and financial performance (FP) has been addressed in prior studies, research remains limited. [9] noted a scarcity of studies exploring EMA's impact on FP, particularly those incorporating mediating variables. For instance, [14] examined the relationship between EMA and organizational performance but overlooked product innovation as a mediating variable. [11] confirmed that while many studies have attempted to explain the link between green innovation and organizational performance, the findings remain inconsistent and unclear. Furthermore, [11] emphasized that most research has focused on developed countries, highlighting the need to investigate these relationships in the contexts of developing nations to provide a more comprehensive perspective.

This study aims to examine the relationship between EMA, green innovation (GI), and the financial performance of SMEs in a developing country context, specifically Vietnam. To address this research gap, survey data were collected from management accountants in SMEs, and hypotheses were tested using structural equation modeling with SmartPLS software. This research makes several theoretical and practical contributions. First, it confirms that in a developing country like Vietnam, EMA positively influences FP, with green innovation serving as a mediating factor. However, findings indicate that process innovation has a stronger impact on FP than product innovation for SMEs. These results offer practical insights for SME accountants, illustrating how EMA and green innovation—particularly process innovation—can be leveraged to enhance organizational financial performance.

2. Literature Review

2.1. Environmental Management Accounting and Financial Performance

Environmental Management Accounting encompasses tools and accounting practices designed to support managerial decision-making, aiming to reduce negative environmental impacts and thereby improve economic performance [15]. Financial performance is often regarded as the ultimate outcome pursued by businesses, although it is influenced by numerous factors. Among these, EMA has garnered substantial attention due to its dual role in reducing costs and mitigating environmental impacts, making it a viable solution for achieving sustainable development [15], [16], [17]. As a critical measure of organizational sustainability, EMA is considered a key factor [18].

Despite its recognized importance, studies reveal that the practical adoption of EMA within enterprises remains limited [18], [19], [20], particularly among small and medium-sized enterprises. Research by [17], [18] and [19] confirms that EMA has a positive impact on both environmental performance and financial performance [9], [18]. Overall, prior studies acknowledge that EMA can help organizations enhance their overall performance [21], [22], [23] and boost their financial performance specifically [9], [14], [24], [25]. Based on this foundation, the study proposes the following hypothesis:

H1: Environmental Management Accounting positively impacts the financial performance of SMEs.

2.2. Environmental Management Accounting and Green Innovation

Green innovation (GI) is categorized into green process innovation (PSI) and green product innovation (PTI) [26], [27], [28], [29]. Broadly, GI refers to technological and production method transformations aimed at creating innovative products that foster sustainable development, addressing ecological, economic, and social responsibilities [28], [29]. Green process innovation involves diverse developments in creating and delivering green products or services, whereas green product innovation pertains to modifications in an organization's green products [14].

The relationship between EMA and GI has been explored in a limited number of studies. For instance, [30] found a positive correlation between EMA and process innovation but noted that the correlation between EMA and product innovation was not statistically significant. Conversely, [22] examining the EMA-GI relationship without differentiating between process and product innovation, confirmed a positive association between EMA and GI. Green process innovation tends to be more attainable for small and medium-sized enterprises, as they are often constrained by limited resources. As a result, focusing on green process innovation may lead to more favorable outcomes than attempting green product innovation. Similarly, [14] focusing solely on process innovation, identified a positive relationship between EMA and process innovation. Based on this foundation, the study proposes the following hypotheses:

H2a: Environmental Management Accounting positively impacts green process innovation.

H2b: Environmental Management Accounting positively impacts green product innovation.

2.3. Green Process Innovation and Green Product Innovation

Green process innovation can introduce novelty into production systems, improving product quality, facilitating the development of new products, enhancing existing ones, and minimizing the risk of product defects [26]. The relationship between process innovation and product innovation has been explored in a few prior studies, such as those by [26] and [31]. [26] demonstrated that process innovation positively impacts product innovation. Similarly, [32] argued that process innovation enables SMEs to align production speed with actual demand, mitigating the risks of overproduction. The findings of [26] confirm a positive relationship between process innovation and product innovation. Building on these insights, the study proposes the following hypothesis:

H3: Green process innovation positively impacts green product innovation.

2.4. Green Innovation and Financial Performance

Green innovation helps businesses reduce costs and minimize waste, thereby mitigating the ecological impact of companies and enhancing financial performance [26], [29], [33]. Process or product innovations undertaken by environmentally conscious companies are often referred to as green process or product innovations [14]. Green process innovation can lower operational costs and improve organizational profitability [26], [34].

Green process innovation drives value-added production activities and efficient operations by integrating advanced machinery and new technological methods, thereby improving overall company performance [35]. [36] further highlighted that process innovation can enable better and more efficient resource utilization, significantly reducing environment-related costs. Green process innovation tends to be more attainable for small and medium-sized enterprises, as they are often constrained by limited resources. As a result, focusing on green process innovation may lead to more favorable outcomes than attempting green product innovation. Additionally, the findings of [9] show that both product and process innovations positively impact financial performance and act as mediators in the relationship between EMA and financial performance. Based on these insights, the study proposes the following hypotheses:

H4a: Green process innovation positively impacts the financial performance of SMEs.

H4b: Green product innovation positively impacts the financial performance of SMEs.

With the above hypotheses, the study develops the research model illustrated in figure 1.

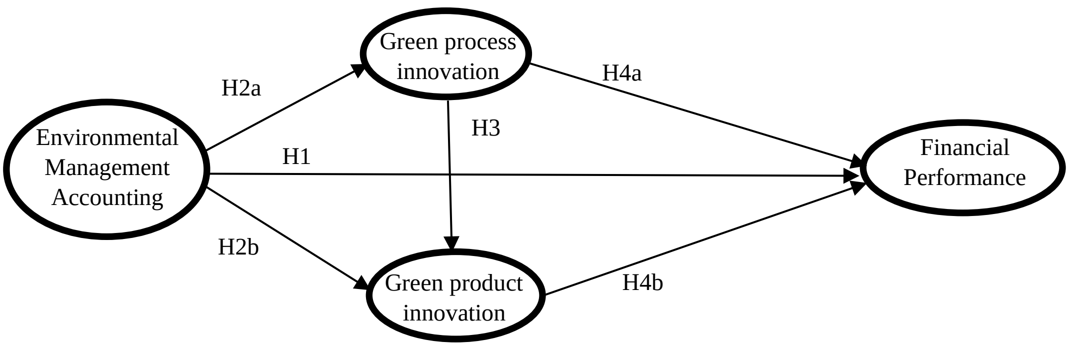

Figure 1. Research Model.

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3. Methodology

3.1. Survey design and data collection

The study selected SMEs in southern Vietnam as the focus of the survey. Southern Vietnam is a region with robust economic development and a high concentration of SMEs, making it a suitable context for sampling. The survey participants consist of financial managers and management accountants in SMEs within the supply chain. Given the limited implementation of EMA in these enterprises, only firms that had adopted management accounting practices, including EMA, were carefully filtered and included in the survey. A total of 280 questionnaires were distributed, with 196 responses received. After screening out invalid responses, 151 valid questionnaires were used for formal analysis. A screening questionnaire was used to identify and reach respondents working in enterprises that have implemented EMA. The study employs the Partial Least Squares Structural Equation Modeling (PLS-SEM) method to analyze the data. PLS-SEM is suitable for small sample sizes, as in this study, and is effective in exploring complex relationships among EMA, GI, and FP.

The demographic analysis revealed that 62.2% of respondents were female and 37.8% were male. The majority of enterprises focus on manufacturing and processing, accounting for 57.6%, while distribution accounts for 42.4%. In terms of educational background, most participants held undergraduate degrees (67.6%), while 32.4% had postgraduate qualifications. Regarding work experience, 41.7% had less than 5 years of experience, 30.5% had 5–10 years, and 27.8% had more than 10 years. Age distribution showed that 36.4% of respondents were under 30 years old, 40.4% were aged 30–40, and 23.2% were over 41 years old. Overall, the sample distribution aligns well with the current research context of SMEs in Vietnam.

3.2. Measurement of the constructs

The study adopted measurement scales derived from previous research. The research model consists of four constructs: EMA, PSI, PTI, and FP. Observed variables measuring these constructs were adapted from established studies. To ensure content validity, a qualitative study was conducted through discussions with experts to determine the content validity and theoretical relevance of the measurement scale. Specifically, the EMA construct comprises six observed variables referenced from [2]. The PSI construct includes four observed variables, while the PTI construct has three observed variables, both referenced from [9]. The FP construct consists of four observed variables referenced from [26]. All items were measured using a 5-point Likert scale, ranging from (1) "strongly disagree" to (5) "strongly agree."

To ensure clarity, the questionnaire items were reviewed by experts in accounting and pre-tested to refine the wording before the formal survey was conducted. For data analysis, this study employed structural equation modeling (SEM) using SmartPLS software. Given the relatively small sample size and the study's focus on theory development and exploring relationships among the constructs (EMA, PSI, PTI, and FP), the PLS-SEM approach was deemed more appropriate than CB-SEM. The analysis results indicated that all constructs achieved acceptable reliability levels, as recommended by [37]. Detailed statistical indices are presented in table 1.

Table 1: Measurement model results

Constructs	Items	Loading	Cronbach'alpha	Composite reliability (CR)	Average variance extracted (AVE)
Environmental management accounting (EMA)	EMA1	0.705	0.896	0.904	0.661
	EMA2	0.777			
	EMA3	0.867			
	EMA4	0.865			
	EMA5	0.843			
	EMA6	0.808			
Financial performance (FP)	FP1	0.877	0.923	0.925	0.813
	FP2	0.909			
	FP3	0.902			
	FP4	0.918			
Green process innovation (PSI)	PSI1	0.830			

	PSI2	0.863			
	PSI3	0.873	0.871	0.871	0.721
	PSI4	0.828			
	PTI1	0.935			
Green product innovation (PTI)	PTI2	0.914	0.915	0.917	0.855
	PTI3	0.924			

4. Results and Discussion

4.1. Measurement model

To assess the measurement model, the study utilized metrics such as Cronbach's alpha reliability, composite reliability (CR), outer loadings, and average variance extracted (AVE). According to [38] and [39], Cronbach's alpha and CR values should exceed 0.7, while AVE values should be greater than 0.5. The analysis results indicate that the measurement model meets these requirements. Specifically, all Cronbach's alpha values exceeded 0.7, ranging from 0.871 to 0.923, while CR values were also above 0.7, ranging from 0.871 to 0.925. Outer loadings were all above the threshold of 0.7, demonstrating strong reliability and good quality of the observed variables [38]. Additionally, the AVE values ranged from 0.661 to 0.855, exceeding the minimum recommended threshold of 0.5, thereby ensuring reliability and convergent validity.

Discriminant validity was assessed using the Heterotrait–Monotrait ratio (HTMT) and the square root of AVE. The results, presented in table 2, show that HTMT values were all below 0.85, and the square root of AVE values exceeded the correlations between constructs in the model. Furthermore, the variance inflation factor (VIF) values were all below 2, indicating the absence of multicollinearity. The adjusted R^2 values for FP, PSI, and PTI were 56.5%, 22.9%, and 24.8%, respectively, indicating the explanatory power of the model for these constructs.

Table 2. Discriminant validity with HTMT

	EMA	FP	PSI	PTI
EMA	0.813	0.570	0.544	0.327
FP	0.527	0.902	0.757	0.616
PSI	0.484	0.679	0.849	0.564
PTI	0.297	0.568	0.504	0.924

Note: The square root values of AVE are presented in bold and positioned on the diagonal. The HTMT values are italicized and placed above the diagonal. The correlation values between variables are located below the diagonal. EMA-Environmental management accounting, PSI -Green process innovation , PTI-Green product innovation, FP-Financial performance.

4.2. Structural model

The research hypotheses were tested using path analysis. The results of the path analysis reveal the relationships between constructs as shown in table 3. A bootstrapping technique with 5000 iterations was employed, indicating that four hypotheses were supported, while one hypothesis was rejected.

Specifically, H1, which proposed a positive relationship between EMA and FP, was supported with a coefficient of $\beta1 = 0.239$ and $p < 0.05$. H2a, which suggested a positive relationship between EMA and PSI, was also supported with a coefficient of $\beta2a = 0.484$ and $p < 0.000$. However, H2b, proposing a positive relationship between EMA and PTI, was not supported, with a coefficient of $\beta2b = 0.069$ and $p > 0.05$, indicating that H2b was rejected. In contrast, H3, proposing that PSI positively influences PTI, was supported with a coefficient of $\beta3 = 0.419$ and $p < 0.000$. Both H4a ($\beta4a = 0.471$, $p < 0.000$) and H4b ($\beta4b = 0.286$, $p < 0.000$) were supported, indicating positive effects of PSI and PTI on FP, respectively.

Table 3. Results of path coefficients.

Structural path	Path coefficients (β)	p values	Conclusion
	Direct effect		
EMA → FP	0.239	0.022	H1 supported
EMA → PSI	0.484	0.000	H2a supported

EMA → PTI	0.069	*0.462*	*H2b not supported*
PSI → FP	0.419	0.000	H3 supported
PSI → PTI	0.471	0.000	H4a supported
PTI → FP	0.286	0.000	H4b supported
	Indirect effect		
EMA → PSI → PTI	0.228	0.000	Supported
EMA → PTI → FP	0.020	*0.460*	*Not supported*
EMA → PSI → FP	0.203	0.000	Supported
EMA → PSI → PTI → FP	0.065	0.004	Supported
PSI → PTI → FP	0.135	0.002	Supported

The analysis of indirect effects reveals that EMA indirectly influences FP through PSI and PTI. Specifically, EMA indirectly impacts FP via the mediation of PSI, with an indirect coefficient of $\beta = 0.203$ and $p < 0.000$. Thus, in addition to the direct effect of EMA on FP, there is also an indirect influence through PSI. Similarly, PSI not only directly affects FP but also indirectly influences FP through the mediation of PTI, with a coefficient of $\beta = 0.135$ and $p < 0.05$. Figure 2 illustrates the path analysis results of the relationships within the research model.

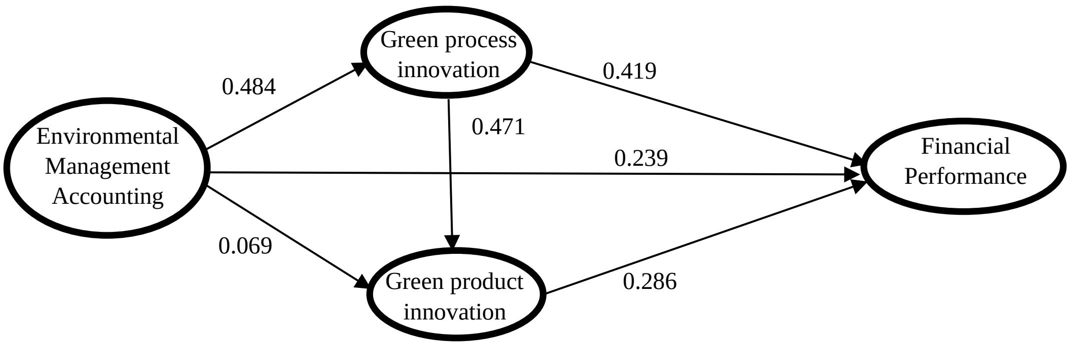

Figure 2. Analysis of PLS-SEM results

4.3. Discussion

The relationship between EMA and environmental performance has been explored in several previous studies, yet the findings remain inconsistent. Among these, the examination of the relationship between EMA and FP has not been fully addressed. Many studies focus on the overall organizational performance rather than considering individual components, such as financial performance. The results of this study support Hypothesis H1, demonstrating a positive relationship between EMA and FP. This finding aligns with the research of [9], which suggested that when SMEs implement EMA, it stimulates efficient resource use, reduces costs, and improves product quality, leading to better financial performance. The relationship between EMA and GI in general has also been addressed in prior studies, such as those by [8] and [22], all of which show that EMA positively influences GI. However, [14] only considered GI in terms of process innovation, without discussing product innovation. This study's findings also show that EMA positively affects PSI, which is consistent with the research of [14] and [9].

This study also reveals that EMA does not affect PTI, a finding consistent with [9], who argued that SMEs often face resource constraints, making it difficult for them to innovate products. Instead, they focus their resources on process innovation, primarily aiming to improve financial performance. In other words, SMEs are more likely to allocate resources to process innovation rather than product innovation because the latter is more challenging and costly. This strategy ultimately helps improve the organization's financial performance.

Although EMA does not directly promote product innovation, it drives process innovation, which in turn supports product innovation. Ultimately, both process and product innovations have the potential to enhance the financial performance of SMEs. This result is consistent with the studies of [9] and [26], which argue that both process and product innovations impact the financial performance of SMEs. Additionally, unlike the study by [9], this research shows that process innovation also positively influences product innovation. The relationship between process innovation and product innovation remains inconsistent. This contrasts with some earlier studies, such as [40] and [41], which suggested that process innovation does not affect the financial performance of SMEs. The rapid technological development and environmental pressures faced by SMEs today may have shifted managers' perceptions of the key aspects of innovation and sustainable development, aligning with current trends. According to [42], environmental degradation in Vietnam is a significant issue with serious economic consequences, placing considerable pressure on both the government and businesses. With advancements in technology, cutting-edge innovations can be leveraged to enhance resource efficiency, reduce waste generation, and promote the sustainable utilization of natural resources.

5. Conclusion

This study focuses on SMEs in the context of a developing country like Vietnam to examine the relationship between EMA, GI, and FP. In this study, GI is approached through process innovation and green product innovation. Survey data was collected and processed using SmartPLS software to assess the measurement model and test the research hypotheses. The results indicate that the measurement model meets the required standards, ensuring reliability, convergence, and discriminant validity. Structural model analysis to test the hypotheses shows that out of the six hypotheses, five are supported, including H1 (EMA positively affects FP), H2a (EMA positively affects PSI), H3 (PSI positively affects PTI), H4a (PSI positively affects FP), and H4b (PTI positively affects FP). However, hypothesis H2b, which posits a positive relationship between EMA and PTI, was not supported.

The findings of this study provide several significant implications both theoretically and practically. Theoretically, this study provides evidence of the relationship between EMA, PSI, PTI, and FP, a relationship that has been minimally explored in previous research. Thus, this study contributes to the theory related to environmental management accounting, which should be considered alongside green innovation to enhance the financial performance of organizations. The relationship between EMA and GI has been explored by only a few previous studies, and the results have been inconsistent. This study suggests that separating GI into PSI and PTI for consideration with EMA is necessary. For SMEs, EMA promotes green process innovation but does not drive green product innovation. This finding is consistent with the recent study by [9]. Moreover, PSI and PTI are seen as mediators in the relationship between EMA and FP. Therefore, focusing not only on EMA but also integrating both green process innovation and green product innovation into environmental efforts can enhance the financial performance of SMEs. This finding is consistent with Institutional Theory and the Resource-Based View, as it highlights the role of green innovation and the implementation of Environmental Management Accounting in enhancing financial performance and promoting sustainable development.

This study also has significant practical implications, particularly in the context of SMEs in developing countries, which have received limited attention regarding EMA practices. Therefore, this study provides important evidence not only for accounting practitioners but also for managers in related fields such as development and innovation concerning sustainable development. Financial performance is the ultimate outcome that managers are concerned with, especially for resource-constrained SMEs. To achieve this, managers need to integrate EMA practices into various aspects of innovation, such as green process innovation, which can help them improve products in an environmentally positive direction in the long term. This will enhance competitive positioning, promote a positive image to stakeholders, and subsequently improve financial performance for the organization.

However, this study also has certain limitations that need to be addressed. First, the study used a convenience sampling method, which somewhat limits the representativeness of the sample. Second, the study focused solely on process and product innovation without considering other aspects of innovation, such as organizational innovation. Third, this study employs a cross-sectional design and data collected through self-reporting, which may be an issue to consider in future research to enhance reliability. Therefore, future studies should include this aspect in the model to provide more comprehensive information. Additionally, this study only focused on financial performance and did not consider non-financial performance, which has been studied in previous research, although it did not show statistical significance. Future studies should consider non-financial performance to provide a more holistic and comprehensive perspective.

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6. Declarations

6.1. Author Contributions

Conceptualization: N.T.H.N; Methodology: N.T.H.N; Software: N.T.H.N; Validation: N.T.H.N; Formal Analysis: N.T.H.N; Investigation: N.T.H.N; Resources: N.T.H.N; Data Curation: N.T.H.N; Writing Original Draft Preparation: N.T.H.N; Writing Review and Editing: N.T.H.N; Visualization: N.T.H.N.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

I declare that I have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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