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Integrating Environmental Cost Accounting with Sustainable Management for Impact Assessment

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Abstract

The negative environmental consequences generated by building material production firms, particularly medium and large-scale ones in Vietnam, have highlighted the importance of good environmental management accounting (EMA) methods.The articles aim to investigate the factors that influence EMA use in the building material sector and the relationship between EMA procedures and financial and environmental performance efficiency.Between 2018 and 2019, a survey of chief management accountants from 600 Vietnamese building material businesses yielded 418 valid replies. The data was analyzed using SPSS 22.0 software.The article identifies six key factors that positively influence EMA implementation: government enforcement, stakeholder interest, positive environmental strategies, community expectations, professional education network, and financial condition, with government enforcement having the most significant impact. Furthermore, it was discovered that EMA adoption considerably improves both financial and environmental efficiencies, supporting the concept that environmental efficiency contributes to financial success.The findings highlight the importance of government policies and stakeholder interests in encouraging EMA practices among building material firms. Implementing EMA helps achieve environmental sustainability and improves financial performance, indicating that eco-friendly policies benefit both the earth and corporate profitability.

Keywords: *Vietnamese Construction Materials, Environmental Management Accounting, Institutional Theory, Contingency Theory, Legitimacy Theory, Stakeholder Theory, Financial and Environmental Efficiency.*

Introduction

Issues relating to the balance between economic growth and sustainable development have been focused on in international forums. In 1972, The United Nations Conference on Environment took place in Stockholm, Sweden. This forum indicated global environmental concerns [1]. This conference was a driving force for governments of developing countries, including Vietnam, to issue regulations on pollution control. In addition, in 1992, the Summit on Earth in Rio de Janeiro also pushed organizations to raise their awareness to achieve sustainable business operations and minimize environmental impacts. An organization's competitiveness is directly and/or indirectly influenced by the growing environmental concerns of stakeholders such as governments, investors, customers, and communities [2]. Although the environment is becoming an increasing issue in many countries [3], traditional management accounting practice has many cognitive limitations related to environmental performance [4], [5], [6] [7]. A traditional accounting system does not provide a specific view of environmental impacts and its related costs but focuses instead on financial performance [3], [8]. Nowadays, the important role of environmental management accounting (EMA) in environmental management has become more obvious. This change reflects major changes in the past two decades [5], [6], [9]. In fact, EMA practices have attracted more significant attention in the management of environmental activities. Even though EMA is spreading throughout the world and has recently been widely adopted at a growing level in some Asian countries [5], [10], EMA is not popular in Southeast Asia [11]. Vietnam is no exception. EMA is considered a new field in both management research and practice in this country [12].

Prior empirical studies on the relationship among influential factors and EMA applications have considered one or two of four theories, but do not address all four theories including institutional, contingency, legitimacy, and stakeholder theory, except for Chang [13], who pointed out that the three biggest barriers to the application of EMA at RMIT University in Australia were financial constraints, government pressure,

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and environmental uncertainty. Jalaludin et al. concurred that there have not been many discussions about the theoretical basis for EMA practices [14]. From the perspective of institutional theory, Jalaludin et al. [14] investigated the quantitative relationship between coercive pressure, normative pressure, imitation pressure, and the adoption of EMA in manufacturing enterprises in Malaysia. While the results indicated that there was only a positive relationship between coercive pressure and the application of EMA, Jalaludin et al. [14] demonstrated that government pressure and normative pressure significantly affect the application of EMA. Qian and Burritt [15] also considered the possibility of developing EMA under four institutional factors, including regulatory pressure, environmental changes, professional relationships, and imitation pressure. Their research results suggested that professional relationships were the most important factor, followed by imitation pressure, and environmental changes. Government pressure is an indirect factor but is not strong enough to support the development of EMA because the government only promotes a voluntary, rather than obligatory, program.

Based on uncertainty theory, Qian and Burritt [15]conducted in-depth interviews with 12 environmental managers representing 12 local government agencies of New South Wales, Australia. The findings indicate that two uncertain factors consisting of environmental uncertainty and environmental strategy positively influence EMA practices that are able to ensure efficient waste management activities. These results are in line with the survey results of [16]. In addition, Mukwarami et al. [17] argued that the positive impacts of environmental uncertainty, financial conditions, and education and professional development on the implement of EMA belong to four sectors: transport, telecommunications services, IT, and retail. Further, from in-depth interviews with seven managers of three paper manufacturing enterprises in Thailand, Suranatthakul et al. discovered barriers affecting the adoption of EMA practices, including the skill and knowledge of the accounting division and environmental strategies [18].

As part of legal theory and stakeholder theory, Le et al. interviewed 53 companies in the UK and Japan about their motivations for applying EMA to achieve sustainable development goals [19]. The results show that companies are driven by an impetus to focus on the most influential stakeholders. They debated that integrating an EMA system into one's practices could be a way of legitimizing a company's internal operations if the pressure from its stakeholders is strong enough. In particular, customer pressure is a strong factor in complying with environmental activities and reporting environmental information in seven environmentally sensitive businesses in the fields of services, building, manufacturing, and afforestation [20].

Many studies exist on the factors impacting the application of EMA. However, the research methodology used in previous studies was mainly qualitative. The previous literature has supplied opinions, conclusions, and solutions based on qualitative results obtained through in-depth interviews and case studies. Quantitative research methods occur sparingly, especially in emerging economies. This view is supported in [21], where was argued that there were limitations in knowledge and understanding of the application of EMA practices in developing countries. Although some studies of EMA practices have used quantitative methods [22], [23] the sample sizes are small, which can limit the research results. On the other hand, there is no research on EMA in the field of construction materials, a dirty industry that leads to significant environmental problems. Therefore, the context of this study is one of its novelties.

Many empirical studies have investigated the effect of corporate environmental performance on financial performance with confusing results. Greenhouse gas reduction improves the return on equity (ROE) relating to long-term financial efficiency, while it does not significantly affect return on sales (ROS) reflecting its short-term financial performance. Based on an empirical analysis by Czech firms, the results strongly indicate that better environmental performance improves profitability by driving down costs more than revenue [24]. In other words, by reducing air pollutant emissions through a prevention strategy, companies are able to effectively minimize their overall costs by avoiding regulatory sanctions and lowering emission charge payments [25]. Similarly, poor environmental performance has a significant negative effect on the intangible asset value of publicly traded firms [26]. As per the debate found in [4], firms certainly spend much money when applying for environmental permits, installing mandatory technologies, and reporting their environmental impacts. The results of [27] indicated that carbon performance significantly negatively impacts financial outcomes in publicly listed companies, suggesting worse carbon performers

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tend to enjoy higher financial performance, while no significant correlation was found between the two efficiencies in private companies. Although many studies estimated the relationship between environmental and financial performance, previous empirical literature observed only mature market economies [27]. Additionally, the relationship between the application of EMA and firm performance represents a new issue in the literature. To the authors' best knowledge, no previous study has discussed this statistical link between these two elements. Unlike many previous studies, we investigated the impact of the implement of EMA practices on firm outcomes, as well as the influence of environmental outcomes on financial outcomes in the transition economies of Vietnam [1].

Construction material manufacturing enterprises in Vietnam contribute 7.5% of the GDP and 9% of the total employment every year Nevertheless, the Vietnamese construction material industry is one of the largest sectors consuming raw materials, using energy, and generating emission. Wastes that arise from all phases of business activities in this industry create serious consequences for the environment. As a result, enhancing economic performance in parallel with minimizing environmental impact must be given priority. To combat these issues, the Vietnamese government has issued regulations on sustainable development planning for the construction material manufacturing industry from 2020 to 2030 [28]. In addition, some environmental management initiatives and programs from manufacturers have been introduced to address environmental problems but the tracking, calculation, and reporting of environmental information have not been investigated [29]. This gap has led to the need to study the EMA in this industry. This study combines many of the best features of the previous research to address three objectives. The first objective is to identify factors influencing the application of EMA. The second objective addresses relationships between EMA application and firm efficiency, while the third objective explores the impact of environmental efficiency on financial efficiency in Vietnamese construction material manufacturers. Findings from this study are valuable to expand appropriate strategies to help Vietnamese construction material manufacturers achieve sustainable development. This study can also significantly contribute to further research that relates to the adoption of EMA in developing countries like Vietnam, where few studies of EMA have been carried out.

Study Objective

The key objective of the article is to create a complete framework that combines environmental cost accounting procedures with sustainable management principles. This integration intends to provide a robust technique for measuring the environmental impacts of corporate activities and their financial implications, allowing for more informed decision-making in the pursuit of environmental stewardship and sustainable growth.

The study will examine how environmental cost accounting can be effectively linked with sustainable management practices to quantify and control the environmental costs of manufacturing processes, product life cycles, and service delivery. A particular emphasis will be given to identifying and pricing environmental externalities, frequently overlooked in traditional financial accounting. This includes the costs of resource depletion, waste management, emissions, and the loss of ecosystem services.

The scrutinising to bridge the gap between financial performance and environmental responsibility by scrutinising existing models and developing approaches. The goal is to help organisations move away from a profit-maximising mindset and towards one that balances economic success with ecological sustainability. Also, the study seeks to operationalise the 'triple bottom line' concept—profit, people, and the environment—by offering actionable insights into how organisations might incorporate environmental expenses into their financial analysis and reporting procedures.

The article is also set to contribute to the policy development debate by offering empirical evidence and practical methods for guiding the implementation of rules that incentivise environmentally friendly company activities. It is expected that by providing a clearer picture of the financial consequences of environmental decisions, organisations will be motivated to adopt more sustainable practices consistent with global sustainability goals and standards. The ultimate goal is to develop a standardised approach that

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aligns ecological impact assessment with business financial success, thus encouraging the adoption of more sustainable practices across industries.

Problem Statement

The existing business paradigm faces a severe challenge due to the need for more alignment between environmental effects and corporate financial accounting. Conventional financial accounting methods frequently need to accurately measure the actual expenses associated with environmental factors, resulting in an inaccurate portrayal of a company's financial standing and the ecological impact of its operations. This discrepancy impedes organisations from comprehensively grasping and incorporating the environmental expenses of their activities into their management and strategic frameworks.

There are two aspects to the situation. More comprehensive approaches are needed to include environmental expenses in the financial accounting framework. Furthermore, organisations need help aligning these expenditures with sustainable management practices. As a result, this misalignment can cause corporate practices that are not sustainable, which can put long-term profitability at risk and contribute to environmental damage.

In addition, the current models for accounting for environmental costs are not widely accepted, mainly because of their complexity, the challenge of measuring the environmental impact, and the belief that ecological metrics conflict with financial performance. Despite increasing data, the belief that sustainable environmental measures can enhance economic performance and resilience remains unchanged. There is an urgent requirement for a system that streamlines the incorporation of ecological expenses into financial reporting and showcases the harmony between environmental sustainability and economic objectives.

The lack of standardised protocols for quantifying and disclosing environmental expenses hinders organisations from making well-informed choices that accurately account for the financial implications of environmental sustainability. This lack of comprehension can also result in organisations encountering heightened risks from regulatory fines, harm to their reputation, and the enduring consequences of mismanaging the environment.

The article aims to tackle these concerns by presenting a system that combines environmental cost accounting with sustainable management for effect evaluation. The objective is to improve the corporate accounting and management environment by integrating environmental factors into financial decision-making, promoting a transition towards both economically feasible and environmentally conscientious sustainability. By addressing these problems, the study will contribute to a business model that is more sustainable and accurately represents the interconnectedness of economic prosperity and environmental well-being.

Literature Review

Management accounting has been developed over the years to focus on resource management and waste minimization to increase value. The development of management accounting has led to newly developed views and techniques, including EMA [5]. EMA was formed and developed by and with strong support from organizations, researchers, and authorities. In 1992, the United States Environmental Protection Agency (USEPA) initiated a voluntary program for EMA development conducted by Environmental Management Accounting Research and Information Center (EMARIC). This program aims to build a unified framework for identifying and defining environmental costs, establishing principles, and integrating environmental information in the decision-making process [6].

In the late 1990s, another project on EMA was developed by the European Commission on Climate Change (ECCC). This project, named Ecological Management Accounting (ECOMAC), was a significant environmental management tool. This project was carried out between 1996 and 1998 in 84 organizations of four European countries, including Germany, the Netherlands, Italy, and England. The aim of the project was to identify potential environmental issues. As a result, it was concluded that regulations relating to

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publishing environmental reports can promote the implementation of EMA. After the ECOMAC project, the ECFCC continued studying EMA through the European Environmental Management Accounting Network (EMAN) Europe in 1998. This network includes researchers, consultants, and businessmen interested in EMA practices. This network was later developed in Asia in 2000, in the United States in 2002, and in Africa in 2005 [6]. Since 2000, EMA has become more popular in research and practice. EMA has been viewed as an extension of management accounting in solving environmental problems [7]. Management accountants are trained to improve the quality of environment-related information and apply it in decision-making for investment appraisal, capital budgets, and strategic management because management accountants play an important role in verifying the honesty and reliability of information from tracking, collecting, and disclosing information to more strategic roles in policy and planning [2], [3], [6], [21].

Many definitions of EMA have appeared in documents and show the difference in the scope or boundaries of applications. Generally, EMA emphasizes main contents, such as EMA being a part of management accounting and providing environmental information for internal management. EMA, which is the intersection between environmental accounting and management accounting [30], not only includes monetary information but also physical information [10]. Although the main purpose of EMA practices is to provide environmental information for business strategies (Table 1), information collected from EMA may also be used for other purposes, such as external reporting [5].

Collecting Information		EMA Practices		Decision Making
- Environmental audit - Environmental impact assessment - Environmental risk appraisal - Product cycle analysis	⇨	- Calculate environmental issues (cost, revenue, asset, debt) - Analyze environmental efficiency	⇨	- Green market development - Activity based management - Synchronous quality management - Pollution prevention - Product management - Environmental report

Figure 1. The Relationship Between Environmental Management Accounting (EMA) Practices and Decision Making

This study established hypotheses about factors affecting the application of EMA based on four theories including contingency theory, institutional theory, stakeholder theory, and legitimacy theory. Contingency theory alludes to the organizational structure, while the three remaining theories relate to the relationship between organizations and society. These theories directly or indirectly affect each other and should be considered holistically instead of separately. All three theories are considered system-oriented theories. They focus on one's role in providing information about the relationship between organizations and governments, individuals, and other related groups [31]. Stakeholder theory sees an organization's stakeholders as an individual. Legitimacy theory is considered a comprehensive perspective while institutional theory is recognized as an accepted social rule and/or institutional practice that is indirectly affected by the organization's stakeholders. Stakeholder theory and legitimacy theory explain why managers chose a detailed strategy, such as disclosing voluntary environmental information, while institutional theory examines larger issues, to explain why an organization accepts a detailed strategy in practice. In addition, stakeholder and legitimacy theory explain how an organization tries to gain legitimacy among a stakeholder group, while institutional theory specifically explores what organizations do to implement such regulations [4].

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Qian and Burritt [15] recognized that to achieve objectives, an organization must meet its functional requirements and remain consistent with its organizational structure and management process. The functional characteristics of an organization, such as its strategy, technology, scale and resources, are called "uncertainties".

The uncertain relationship between the environment and a business strategy can influence the design of a management accounting system. Changes in environmental strategies will create changes in management accounting systems to provide more accurate environmental information. Environmental strategy is a part of overall actions needed to manage the interactions between the economy and the environment. The selected environmental strategy often identifies the setting for environmental governance, including EMA [32]. Qian and Burritt [15] proposed that contingency theory is connected with environmental accounting, environmental strategy, and uncertainty. Environmental accounting is designed to support and facilitate environmental strategies. The more positive the environmental strategy, the higher the development of environmental accounting and the wider the scope of environmental accounting information. When environmental issues become more flexible and uncertain (for instance, the changing demand for green products and markets), organizations will surely use environmental accounting tools to deal with changes.

Yang [33] specified that companies with different environmental strategies require different management information systems to improve organizational effectiveness. Accounting information systems, which play an important role in an organization's activities, impact their success by shaping the strategies. According to Amatulli et al. [34], an environmental strategy can be divided into two aspects: negative and positive. Organizations invest in waste treatment technology as a solution to deal with environmental regulations or reduce pressures from stakeholders which can be classified as negative environmental strategies. On the contrary, organizations voluntarily choose clean technology to redesign their production processes, with the intent to reduce the environmental impacts or prepare for future compliance (called positive environmental strategies). Once an organization chooses an active and positive environmental strategy, it is certain that the organization will change its management accounting system and adopt better practices. Conversely, organizations pursuing passive environmental strategies may continue to depend on their current system. In other words, a management accounting system is less likely to be improved and changed. Therefore, if an organization integrates the environment into its business strategy and determines positive environmental programs, their management accounting system will be better able to collect, calculate, and provide useful information, including environmental information.

Methodology

Sampling

According to Le [3], in Vietnam, construction investment accounts for about 70% of social investment, of which construction materials reach 30%–50% of the total construction investment. Therefore, the development of the building material industry not only helps the construction industry and real estate industry develop sustainably but also contributes significantly to economic and social development in Vietnam. In 2017, the total revenue of construction materials reached nearly VND 400,000 billion (nearly USD 17 billion), accounting for 7.5% of the GDP. Vietnam's construction materials products were exported to 120 countries with a turnover of over USD 1670 million in 2017, accounting for 20%–50% of the total output. The goal of the Vietnamese construction material industry is to reach an export turnover of USD 2 billion by 2020. The ratios of each main material in the total design capacity are: cement: 20%–30%, paving materials: 25%–30%, flat glass: 20%–30%, sanitary porcelain: 30%–40%, lime: 30%–50%, and steel: 20%–25%. By 2030, the construction material industry must advance its production technology, achieve high levels of automation, reduce its raw material and energy consumption, minimize its environmental pollution, and reduce its CO2 emissions. Building materials are one of the industries that consume the most resources and energy and present the highest risk of environmental pollution.

Although many construction material enterprises in Vietnam have started reporting environmental information in their annual reports or providing separate environmental reports, such as environmental

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impact reports and environmental monitoring reports, a few enterprises use environmental information for internal management purposes. There is also little research on EMA to explain why EMA is adopted or not adopted. Due to this paucity of information, there is little understanding of EMA, and the factors affecting EMA application have not been discovered for this industry. The present study selected the construction material industry because it has significantly negative impacts on the environment, such as consuming a huge amount of resources, turning cultivated land into ponds and lakes, causing erosions, and seriously affecting ecosystems and landscapes. Every year, the construction material industry generates emissions, dust, and toxic waste, affecting the environment and increasing greenhouse gas emissions, environmental treatment costs, and pollution management and prevention costs. Therefore, it is necessary to control and manage the environment in construction material enterprises. The scope of research is the construction material industry in Vietnam at both medium and large scales, because large and medium-sized enterprises are able to apply EMA, while small-scale enterprises without much understanding of EMA do not fully adopt EMA.

This study conducted surveys of chief management accountants in construction material enterprises, as these subjects have the most knowledge about EMA practices, the factors affecting EMA application, and the relationship between EMA and performance efficiency. The questionnaires were sent online or directly to the chief management accountants of 600 construction material enterprises in Vietnam during the period from June 2018 to January 2019. First, the authors sent the questionnaire directly to the chief management accountants of 50 enterprises which enabled us to collect initial information and find out whether the respondents really understood the issues. After directly discussing the contents of the questionnaire, the authors found that the respondents comprehended the information. During the survey, the authors often called to remind them and explain and exchange questions, as required. The survey results obtained 435 responses from which 17 invalid responses were removed, and 418 valid responses were retained which met the required sample size to reach 95% confidence in the statistical results.

Questionnaire Design

Questionnaires were used as the instrument for data collection. There were four sections on the questionnaires that were developed based on the study's objectives. The first section aimed to describe the characteristics of respondents, such as gender, educational level, and work experience. The second section raised questions about the application of EMA practices, and the third part dealt with the factors influencing EMA application. The final part offered questions about financial and environmental efficiency of the enterprise. The research model was developed by the authors to explore the three objectives (see Figure 1).

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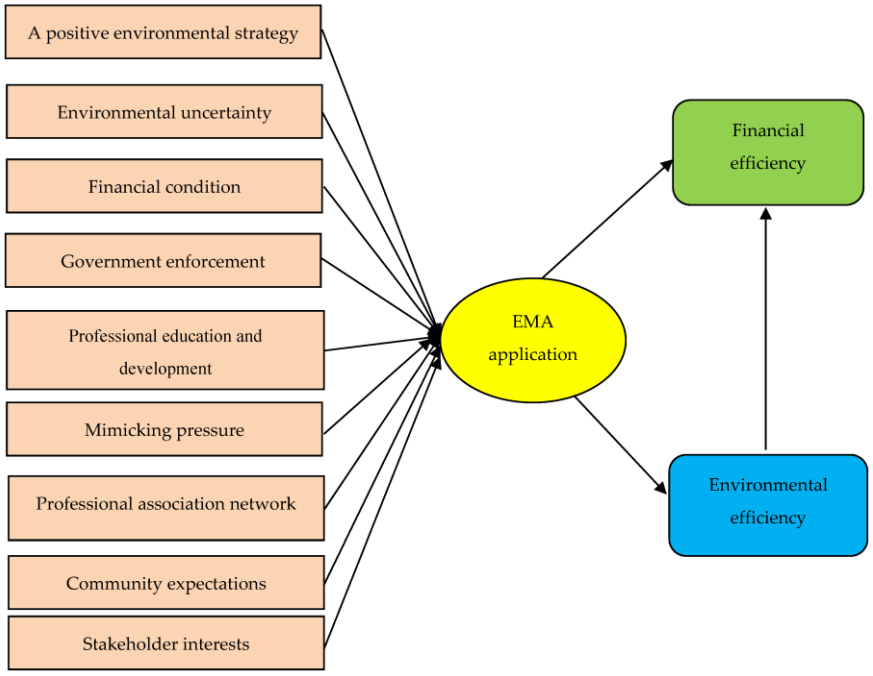

Figure 2. Research Model

All scales of influencing factors, EMA application, and performance efficiency were measured, on a Likert scale from 1 to 5. For influencing factors, a five-point Likert scale with 1 = no application and 5 = full application was used, while a five-point Likert scale where 1 = no implementation and 5 = full implementation was used for the EMA variable. For firm efficiency, respondents were asked to evaluate financial and environmental efficiency relative to the main competitors over the last three years. The efficiency indicators were measured using a five-point Likert scale (ranging from 1 = "much worse than competitors" to 5 "much better than competitors"). There were 36 scales for influencing factors, 10 scales for EMA application, 3 scales for financial efficiency, and 3 scales for environmental efficiency. Scales of the factors, EMA application, and performance efficiency were inherited from previous studies, except for the three scales of influencing factors, where 'Professional association network' was exchanged with research experts which were developed by the authors.

Data Analysis

Valid questionnaires were encoded, declared, and entered into SPSS software, version 22.0. From the software, the data continued to be processed via reliability testing, descriptive statistics, factor analysis, and regression analysis. Testing scale reliability was assessed by testing the consistency of the entire scale with Cronbach's alpha and corrected item-total correlation as the most widely used measures. The generally agreed upon lower limit for Cronbach's alpha is 0.60 and for corrected item-total correlation is 0.30 in exploratory research. A descriptive statistical technique was used to analyze the frequency and percentage of the background of target respondents and describe basic characteristics of scales with mean and standard deviation. Moreover, the skewness value was used to examine the balance of the distribution. If the skewness coefficients of observed variables range from −1 to 1, the observed variables will reach the normal distribution [8].

The influence of the factors on the adoption of EMA and the effect of the adoption of EMA on firm performance were also analyzed in this study with exploratory factor analysis (EFA) and multiple regression analysis. According to Wolters et al. [7], to conduct an exploratory factor analysis as well as multiple regression analysis, the number of samples must be at least five times higher than the number of scales. In this study, there were 52 scales and the samples were equal to 418 (eight times higher than the number of scales). Thus, exploratory factor analysis method was used completely.

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The Steps Taken in The EFA Method Were:

Step 1: Kaiser−Meyer−Olkin (KMO) test was used to measure sampling adequacy for each variable in the model while Bartlett's test was used to test if variances were equal for all samples. Factor analysis is appropriate when the KMO value ranges from 0.5 to 1. The significant value of Bartlett's test of less than 0.05 demonstrates that the variables are correlated with each other.

Step 2: An extracted variance table was built to determine the number of factors extracted and the percentage as an explanation of the factors. The standard for extracted variance was greater than 50%.

Step 3: A rotated component matrix table showed how many scales were considered for each factor. The table contains the factor loadings for each variable on each factor. Factor loadings indicate the degree of correspondence between the variable and the factor, with higher loadings making the variable representative of the factor. Factor loadings greater than 0.50 were considered significant.

For the multiple regression analysis, three steps were performed, as follows:

Step 1: A correlation matrix between dependent variables and independent variables was created. The greater the correlation coefficient, the more closely the variables have a relationship. If the significance value of the test was less than 0.05, these variables could be used in a multiple regression model.

Step 2: The adjusted square R coefficient and ANOVA analysis were used to assess the suitability of the regression model. The larger the adjusted square R coefficient, the higher the relevance of the model. If the significance value of the F test in the ANOVA analysis is less than 0.05, it can be concluded that the model is suitable.

Step 3: The regression coefficients of the independent variables included in the model were determined. This study used a stepwise method to select the most appropriate model. If the significance values of the regression coefficient test are less than 0.05, the independent variables are related to the dependent variable. In addition, among independent variables there is no multicollinearity, according to King and David [35], when the variance inflation factor (VIF) values in the coefficients table are less than 10. The Durbin−Watson test was conducted to measure autocorrelation in the residuals from the regression analysis. Values of the Durbin−Watson test of less than 1 show that there is a positive autocorrelation, while values between 1 and 3 indicate no autocorrelation, and test statistic values in the range of 3−4 indicate negative autocorrelation.

Results

Profile of Sample

Figure 2 shows general information for the respondents. Among the 418 respondents, the number of females (71.1%) was much higher than the number of males (28.9%), which agrees with the professional characteristics of accounting in Vietnam. For the education level, university degrees had the highest rate with 65.6%, followed by post-graduate (27.5%) and college (6.9%). Chief management accountants had a high level of education, ensuring the reliability and quality of survey responses. For years of experience, the number of respondents who have acted as chief management accountants from 5 to less than 10 years was the highest (30.4%), followed by 10 to less than 15 years (23.7%), 15 to less than 20 years (17.7%), more than 20 years (16.7%), and 1 to less than 5 years (11.5%). Ultimately, the respondents with extensive experience in the field of accounting clearly understood how environmental information is calculated, aggregated, and reported and whether or not environmental information is primarily considered in business decisions.

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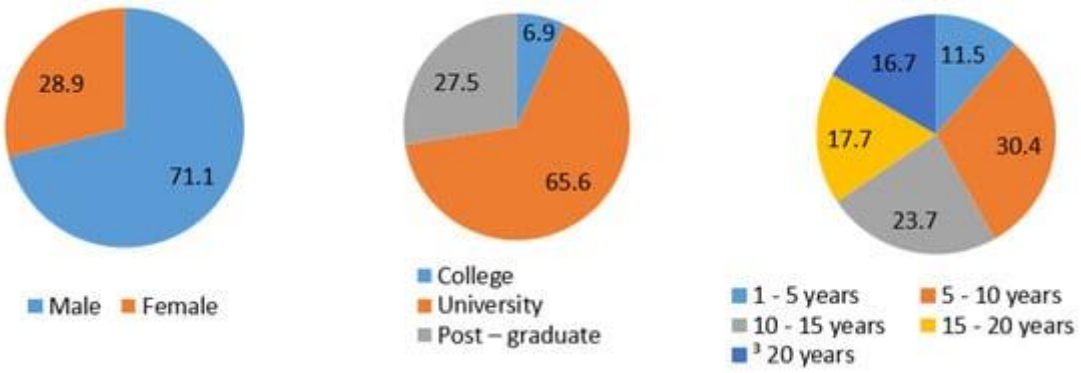

Figure 3. The Characteristics of Respondents

Factors Influencing EMA Application

This study tested the reliability of all scales for factors affecting EMA application. Shown in Appendix B, the corrected item-total correlation of the scales was greater than 0.5 (ranging from 0.511 to 0.850) and the Cronbach's alpha if item deleted coefficient was greater than 0.7 (between 0.726 and 0.915) which indicates that all scales were acceptable with good reliability. In other words, in reliable tests using 10 scales to analyze EMA application, similar results were consistently shown (see Appendix B). Corrected item-total correlation values of the variables were between 0.620 and 0.832, Cronbach's alpha if item deleted values ranged from 0.903 to 0.915. The skewness values of all items in [−1; 1] show that the observed variables follow standard distribution.

Table 1 shows that the KMO value was 0.907 [0.5;1] and the significance value of Bartlett's test was less than 0.05 (Sig. = 0.000). Therefore, factor analysis was suitable.

Table 1. Kaiser−Meyer−Olkin (KMO) and Bartlett's Tests

Kaiser−Meyer−OlkinMeasure of Sampling Adequacy		0.907
Bartlett's Test of Sphericity	Approximate Chi-Square	12335.894
	df	630
	Sig.	0.000

Table 2 shows the number of factors extracted and an explanation of the factors. The initial eigenvalue was greater than 1 among the eight factors that were extracted. The cumulative percentage value (75.664%) was higher than the recommended critical value of 50%. The results indicate that the first eight factors explain 75.664% of the total variance in the observed variables.

Table 2. Total Variance Explained

	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	12.432	34.533	34.533	12.432	34.533	34.533	5.418	15.050	15.050
2	4.703	13.063	47.597	4.703	13.063	47.597	4.179	11.607	26.657
3	2.620	7.277	54.874	2.620	7.277	54.874	3.650	10.138	36.795
4	2.035	5.652	60.526	2.035	5.652	60.526	3.508	9.746	46.540
5	1.764	4.899	65.426	1.764	4.899	65.426	3.308	9.189	55.729
6	1.355	3.763	69.189	1.355	3.763	69.189	2.644	7.344	63.073
7	1.248	3.468	72.657	1.248	3.468	72.657	2.469	6.858	69.931
8	1.083	3.007	75.664	1.083	3.007	75.664	2.064	5.733	75.664
9	0.749	2.080	77.744						
10	0.673	1.869	79.613						

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11	0.650	1.804	81.417						
12	0.549	1.526	82.943						
…..									

A rotated component matrix was used to determine the number of observed variables in each factor. There were two scales, EDD4 and COE1, that had a factor loading of less than 0.5 and were removed from this model (in Appendix C). Rerunning the model, the final results in Table 3 show the eight factors extracted.

Table 3. Rotated Component Matrix

	Component							
	1	2	3	4	5	6	7	8
PAN1	0.899							
EDD3	0.884							
PAN3	0.874							
EDD2	0.848							
PAN2	0.843							
EDD1	0.819							
ENU5		0.846						
ENU3		0.822						
ENU1		0.815						
ENU4		0.806						
ENU2		0.797						
GOE5			0.761					
GOE3			0.724					
GOE4			0.724					
GOE2			0.703					
GOE1			0.684					
PES1				0.796				
PES4				0.780				
PES2				0.755				
PES3				0.750				
COE2					0.864			
COE3					0.838			
COE4					0.637			
COE5					0.601			
FIC2						0.888		
FIC3						0.869		
FIC1						0.749		
STI3							0.780	
STI4							0.758	
STI1							0.632	
STI2							0.524	
MIP3								0.760
MIP1								0.706
MIP2								0.692

The findings in Appendix D point out that all factors had a positive correlation with the application of EMA, among which four factors including government enforcement, positive environmental strategy, stakeholder interests, and community expectations, had a strong correlation with the application of EMA (i.e., correlation values greater than 0.5). The significance value of the test was less than 0.05 (Sig. = 0.000), indicating that these variables could be used in the regression model.

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A stepwise method was carried out in regression analysis. Results from SPSS 22.0 software show that there were six models. All models had a high adjusted R2 coefficient and a Sig. value in the F-test that was less than 0.05 (Sig. = 0.000) (Table 4). Therefore, it can be concluded that six models were suitable. This study selected the sixth model with the best results. This model had an adjusted R2 value of 0.839 which means that 83.9% of the variation of EMA application is explained by six factors. Moreover, the value of d in the Durbin−Watson test was equal to 1.439 within a range from 1 to 3, showing that there is no similarity between the remainder in the regression model.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin−Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	0.871 [a]	0.759	0.759	0.31816	0.759	1310.925	1	416	0.000	
2	0.895 [b]	0.801	0.800	0.28921	0.042	88.458	1	415	0.000	
3	0.911 [c]	0.830	0.828	0.26814	0.028	68.795	1	414	0.000	
4	0.915 [d]	0.837	0.835	0.26279	0.007	18.020	1	413	0.000	
5	0.916 [e]	0.840	0.838	0.26058	0.003	8.046	1	412	0.005	
6	0.917 [f]	0.842	0.839	0.25946	0.002	4.554	1	411	0.033	1.439

Table 5 shows the results of the significance tests of the R2 coefficient for the whole data used to evaluate the suitability of the model. The results show that the Sig. value was 0.000 (<0.05), meaning that R2 on the whole was significantly different from zero. Hence, the regression model was suitable.

Table 5. ANOVA Test

Model		Sum of Squares	df	Mean Square	F	Sig.
6	Regression	147.143	6	24.524	364.293	0.000 [f]
	Residual	27.668	411	0.067		
	Total	174.811	417			

The results in Table 6 show that there were six factors that had a positive relationship with EMA application, including government enforcement, stakeholder interests, positive environmental strategy, community expectations, professional education and association network, and financial condition. Consequently. In particular, government enforcement had the strongest impact on the adoption of EMA, with a standardized beta coefficient equal to 0.592, followed by positive environmental strategy (beta = 0.168), stakeholder interests (0.153), and community expectations (0.114). Professional education and association network and financial condition are the weakest factors, with standardized coefficients of 0.076 and 0.047, respectively.

Table 6. Regression Analysis of Environmental Management Accounting (EMA) Application

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF

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6	Constant	−0.960	0.113		−8.470	0.000	−1.183	−0.737		
	GOE	0.530	0.025	0.592	21.409	0.000	0.482	0.579	1.984	1.984
	STI	0.139	0.025	0.153	5.553	0.000	0.090	0.189	1.969	1.969
	POE	0.138	0.021	0.168	6.535	0.000	0.096	0.179	1.719	1.719
	COE	0.143	0.031	0.114	4.581	0.000	0.082	0.205	1.604	1.604
	PEA	0.064	0.021	0.076	3.096	0.002	0.023	0.104	1.576	1.576
	FIC	0.040	0.019	0.047	2.134	0.033	0.003	0.078	1.283	1.283

The significance values of the regression test were less than 0.05. Thus, these coefficients are significantly different from zero. In other words, the independent variables in the model had a relationship with dependent variable. The regression model was also significant. The VIF values in the coefficients table were smaller than 2, finding that there was no multicollinearity between the independent variables.

The Relationship between EMA Application and Performance Efficiency

The study examines the reliability about all scales about economic and environment efficiency. The results in Appendix B show that the Cronbach's alpha if item deleted coefficients were greater than 0.8 (from 0.845 to 0.901) and the corrected item-total correlation coefficients of each variable were greater than 0.7 (from 0.787 to 0.861). Thus, these scales ensure high reliability.

According to Table 7, the correlation coefficients between EMA application, financial efficiency, and environmental efficiency were high (with a Pearson correlation greater than 0.6). As a result, these variables had positive and closely correlated relationships. The values of Sig. around 0.000 demonstrate that there are correlations between the application of EMA and financial and environmental efficiency.

Table 7. The Correlations Between EMA Application and Financial and Environmental Efficiency

		EMA	**FIE**	**ENE**
EMA (EMA application)	Pearson Correlation	1	0.720 **	0.689 **
	Sig. (2-tailed)		0.000	0.000
FIE (Financial efficiency)	Pearson Correlation	0.720 **	1	0.916 **
	Sig. (2-tailed)	0.000		0.000
ENE (Environmental efficiency)	Pearson Correlation	0.689 **	0.916 **	1
	Sig. (2-tailed)	0.000	0.000	

Figure 3 shows the influence level of six factors on EMA application, as well as the impact of EMA application on outcomes in the Vietnamese construction material manufacturing industry.

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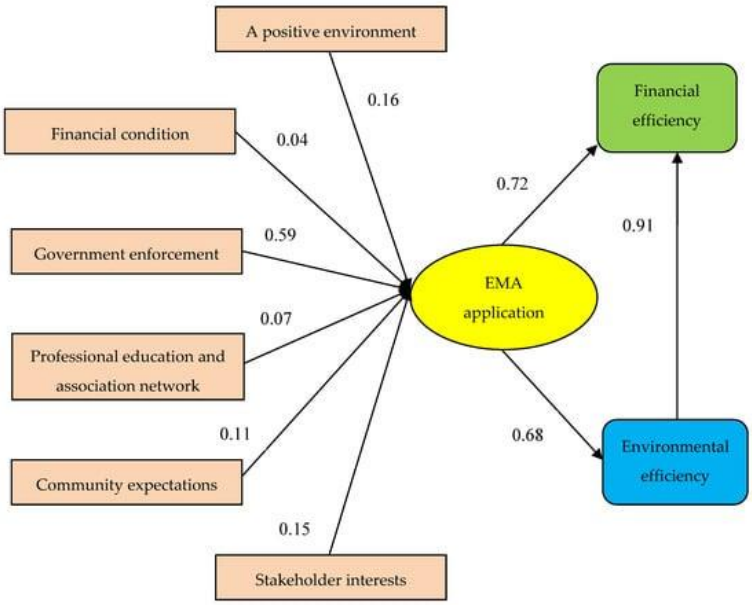

Figure 3. Summary of Research Results.

Discussion

Incorporating Environmental Cost Management Accounting (ECMA) into the strategic framework of firms, namely in the construction material sector in Vietnam, signifies a forward-thinking convergence of environmental considerations with conventional cost accounting. The study discussed in the article provides a comprehensive analysis of the elements that drive the adoption of ECMA and its relationship with financial and environmental performance effectiveness.

The findings align with the research conducted by Le and Nguyen, who emphasise the cognitive constraints of traditional management accounting in addressing environmental performance. They believe that ECMA (Environmental Management Accounting) is a crucial addition to conventional methods to promote sustainable development [3], [5]. Gunasekaran et al. support this observation and stress the importance of incorporating environmental aspects into management accounting through performance measurements and metrics to achieve holistic value creation [5].

The study investigates the factors that affect the adoption of ECMA in academic institutions. It supports Chang's findings that financial limitations, government influence, and environmental uncertainty are significant obstacles to EMA. Among these factors, government enforcement is identified as the most influential. Jalaludin et al. and Qian and Burritt both emphasise the significance of coercive, normative, and mimetic forces in promoting the adoption of environmental management accounting (EMA) within manufacturing companies [14], [15].

In addition, the study compares the findings of Mukwarami et al., who highlighted the beneficial effects of environmental uncertainty, financial conditions, and education on the implementation of EMA in different industries such as telecommunications and retail [17]. This is consistent with Suranatthakul et al.'s findings on the obstacles that hinder the adoption of EMA, such as a lack of skills and inadequate environmental strategies [18].

The study focuses on how government policies and stakeholder interests drive the adoption of Environmental Management Accounting (EMA) practices in building material firms. This aligns with Le et al.'s argument that integrating EMA systems into business practices helps legitimise a company's operations when there is significant stakeholder pressure19. Lestari et al. support this claim by demonstrating the impact of customer pressure and environmental regulation on the performance of green innovation [20].

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The study's quantitative method of examining the correlation between EMA and corporate efficiency provides a unique contribution to the area, especially in emerging economies, with empirical data on this topic. This statement adds to the broader discussion on environmental management accounting, which has traditionally focused on qualitative aspects. Pioneering organisations such as IFAC, UNDSD, and USEPA have provided fundamental principles and advice for worldwide EMA practices [30], [21], [22].

This research provides new insights into Vietnamese building material companies operating in a transitioning economy. It differs from earlier studies that focused on established market economies and emphasises these companies' distinct environmental and financial characteristics. The strong correlation between environmental and economic efficiency highlights the mutually beneficial potential of EMA, confirming that effective environmental performance aligns with financial prosperity. This sentiment is supported by the studies conducted by Castro et al. and Trinks et al., who examined the influence of ecological performance on stock prices and financial performance, respectively [26], [27]

The conversation explores different theories and real-world evidence, emphasising the importance of EMA as a strategic instrument for promoting sustainable growth in the manufacturing industry. The statement emphasises the need for a coordinated strategy that acknowledges the fundamental connection between environmental responsibility and financial sustainability [33], [34]. It calls for improved awareness and decision-making by managers and policymakers, focusing on integrating environmental accounting into all business operations.

Conclusions

The findings from the research results are motivators that will help the Vietnamese construction material production industry promote the application of EMA to achieve sustainable development through suggestions, such as increasing government enforcement, improving professional education and the association network with regards to EMA practices for managers and staff, establishing a positive environmental strategy, and achieving a positive financial condition as well as increasing the community's expectations and stakeholder's interests as follows:

Government coercion plays a large role in supporting the director of the board, environmental managers, and chief accountants in overcoming barriers related to values and professional practices. Although the Vietnamese government has made great efforts in enacting regulations on environmental management to cope with increasing environmental pollution and the scarcity of resources, the government has not enacted policies to improve accountability related to environmental information. As a result, little attention has been paid to EMA practices in this country. This lack of information can reduce the motivation for collecting, identifying, and evaluating environmental information related to decisions of waste management and pollution prevention. In an effort to promote EMA practices, the government needs to develop specific standards, guidelines, and regulations on EMA that help businesses adjust or change their current accounting system to address environmental issues.

Vietnamese construction material enterprises are strongly affected by traditional accounting rules and regulations. Because of limited knowledge and skills in environmental accounting, they are not knowledgeable enough to realize that measuring and assessing environmental information is an essential part of their activities. As a result, environmental issues are not integrated into current accounting practices, and managers do not have the opportunities to use environmental information for appropriate decision making. Therefore, in order to encourage EMA practices, enterprises provide learning mechanisms, including improving their knowledge and skills in managing environmental activities and determining how to identify and measure related environmental information. This mechanism will not only help the environmental information to become clearer in the accounting system but also enhance the position and role of the accounting department. Additionally, this mechanism could be better promoted through professional associations. The network of professional associations on EMA allows all participants to receive the EMA framework and realize the usefulness of EMA practices. Members, such as managers or business consultants, exchange expertise, gain experience, and seek opportunities for sustainable

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development, including environmental performance management. It is concluded that the greater the EMA association network is, the greater the opportunity for members to improve their knowledge of EMA and the higher the effort to integrate aspects of EMA into the businesses.

A positive environmental strategy can enable managers to deeply consider what should be done to minimize the environmental impact and increase financial benefits, such as complying with environmental regulations, establishing voluntary environmental initiatives, and promoting environmental programs aimed at prioritizing cleaner production. A proactive environmental strategy can also help businesses to become more active in the application of ECMA practices. Because of these strategic goals, environmental information (consisting of environmental costs and environmental benefits) is available. This information can motivate businesses to develop solutions for effective environmental management and ensure sustainable operations.

Building and developing the EMA system requires a great deal of money. It seems that EMA practices should be applied to large-scale enterprises that have better financial conditions. Perhaps, in the short term, enterprises spend more of their budget on implementing EMA practices, which will then be offset by the potential benefits of EMA, and in the long term, they will receive positive impacts because of their improved reputation.

The findings show that the community and stakeholders, such as investors and customers, have a positive influence on the adoption of EMA. Community can have a powerful impact on enterprises that have negative impacts on the environment, which will reduce the image and reputation of enterprises. Investors may withdraw capital when enterprises' operations do not meet their expectations on environmental issues. Customers are increasingly inclined to consume green products and place their trust in environmentally responsible businesses. However, in the Vietnamese construction material industry, the EMA application level is low due to the absence of pressure from the community, investors, and customers. These enterprises are less likely to integrate environmental information into their existing accounting systems for the purpose of environmental control and management in order to legalize their internal operations and increase their image and reputation in the eyes of stakeholders. Therefore, once stakeholders are more aware of the environmental impacts, have increased concerns about environmental improvement, and expect improved environmental activities, enterprises will have to develop initiatives to minimize environmental impacts through the identification, measurement, and provision of environmental information. As a result, businesses will attract customers and investors and increase their competitive advantage.

On the other hand, our finding is that the application of EMA practices that improve environmental performance goes hand in hand with enhancing the profitability of enterprises promoted by the enterprises, government, community, and stakeholders. The enterprises should maximize their financial performance and, at the same time, disclose their environmental report and fulfill their social responsibilities under a certain level of EMA application. We believe our results are an important first step in understanding why enterprises invest in the adoption of EMA.

In addition, the significantly positive relationship between environmental efficiency and financial efficiency shows that innovative solutions for the reduction of environmental pollution can promote enterprises' profitability. In general, efforts in minimizing negative environmental impacts by an enterprise will appreciably increase its profitability. Our finding that better environmental performance and better financial profitability go hand in hand is also consistent with the view that financial performance and environmental performance are both related to the quality of management. Excellent managers interested in their firm's long-term targets, accept their firm's social responsibility, and adopt proactive strategies to control environmental pollution. It is suggested that managers should change their outlook of their firm's environmental performance, from complying with government-mandated environmental regulations to focusing on opportunities for cleaner production. This study's results show that good environmental efficiency is associated with good financial outcome, which is good news for those questioning the correlation between environmental sustainability and production efficiency.

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