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Institutional Pressures, Environmental Management Accounting, Eco-Innovation, and Pollution Reduction in SMEs

Pham Thi Kim Thanh[1,2], Nguyen Thanh Tai[1], Tran Thi Thanh Hai[3], Nguyen Le Ha Thanh Na[4], Nguyen Ha Thach[5]*

[1]*School of Finance and Accounting, Industrial University of Ho Chi Minh City, Vietnam.*
[2]*Faculty of Accounting and Auditing, University of Finance - Marketing, Vietnam.*
[3]*School of Accounting, University of Economics Ho Chi Minh City, Vietnam.*
[4]*School of Financial and Banking Technology, University of Finance - Marketing, Vietnam.*
[5]*Faculty of Business Administration, Industrial University of Ho Chi Minh City, Vietnam.*

ABSTRACT

Manufacturing SMEs are a major source of energy and material consumption, wastewater, solid waste, and air emissions, so strengthening their environmental management is central to curbing industrial pollution and protecting surrounding ecosystems. In transition economies, SMEs remain slow to adopt environmental management accounting (EMA), while the effect of EMA on eco-innovation is underexplored. Drawing on institutional theory, the natural-resource-based view, and the dynamic capabilities perspective, this study tests a model in which three forms of institutional pressure, namely coercive, normative, and mimetic, drive EMA adoption, and EMA in turn drives three forms of eco-innovation: eco-product innovation (EPI), eco-process innovation (EPrI), and eco-organizational innovation (EOI). Survey data from 247 manufacturing SMEs in Ho Chi Minh City, Vietnam, were analyzed using partial least squares structural equation modeling (PLS-SEM) in SmartPLS 4. All six hypotheses were supported. Coercive pressure exerted the strongest effect on EMA, followed by normative pressure and mimetic pressure. EMA positively affected all three forms of eco-innovation, most strongly organizational innovation, followed by process and product innovation. The model explained 30.7% of the variance in EMA, 21.6% in EOI, 16.9% in EPrI, and 7.5% in EPI. The finding that EMA most strongly promotes organizational eco-innovation provides a new empirical nuance and contributes evidence from an under-researched transition economy. Beyond its accounting implications, the study shows that by improving firms' capacity to monitor material, energy, water, and waste flows, EMA-enabled eco-innovation offers a practical mechanism for reducing pollutant discharge and mitigating the environmental degradation associated with manufacturing, thereby advancing environmental sustainability, resource conservation, and ecosystem protection in transition economies.

Keywords: *Environmental management accounting, Institutional pressures, Eco-innovation, Small and medium enterprises, Environmental sustainability, Industrial pollution prevention*

Corresponding author: Nguyen Ha Thach
e-mail ✉ nguyenhathach@iuh.edu.vn
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INTRODUCTION

Industrial manufacturing is one of the largest anthropogenic drivers of environmental degradation, generating greenhouse gas emissions, industrial effluent, hazardous and solid waste, and intensive use of energy, water, and raw materials that place ecosystems and public health under increasing strain. In developing and transition economies, the rapid expansion of manufacturing SMEs magnifies these pressures on soil, water, and air quality, making firm-level environmental management a critical lever for pollution control, resource conservation, and biodiversity protection (Begam & Padma, 2025). Environmental pressure from regulators, supply-chain partners, and local communities has compelled many manufacturing enterprises to seek management tools capable of reconciling economic goals with ecological responsibility. Environmental management accounting (EMA) is one such tool. Unlike conventional financial accounting, EMA integrates monetary information, including waste-treatment costs, compliance expenditures, and savings from efficient resource use, with physical data on flows of energy, water, materials, and emissions. EMA thereby supports both daily operational decisions and long-term strategic ones (Latan *et al.*, 2018; Wang *et al.*, 2019; Gunarathne *et al.*, 2021; Le *et al.*, 2025). A growing body of evidence documents a positive association between EMA and firms' environmental and financial performance (Appannan *et al.*, 2022; Deb *et al.*, 2022; Khan & Gupta, 2024; Barani *et al.*, 2025). Yet two foundational questions remain inadequately resolved: what drives firms to adopt EMA, and once adopted, through what mechanism does EMA enable eco-innovation?

The first question is particularly salient for SMEs in transition economies, where firms often lack dedicated environmental personnel and internal incentives to invest in environmental information systems (Ngo, 2023; Nguyen, 2024). EMA adoption is therefore typically reactive, responding to external pressure rather than arising from internal cost-benefit reasoning.

Institutional theory (DiMaggio & Powell, 1983) identifies three isomorphic mechanisms, namely coercive, normative, and mimetic pressures, through which organizations within the same institutional field converge on similar management practices. Most prior research, however, either aggregates these mechanisms into a single construct or examines only a subset of them, leaving the distinct role of each pressure unclear, especially for SMEs (Chaudhry & Amir, 2020; Alnaim & Metwally, 2024; Cao *et al*., 2025).

The second question concerns EMA's consequences for innovation. The natural-resource-based view (Hart, 1995) and the dynamic capabilities perspective (Teece *et al*., 1997) together suggest that EMA functions as an informational resource enabling firms to identify ecological inefficiencies and focus their innovation efforts. Most existing research, however, measures innovation as a composite or links EMA directly to performance outcomes, overlooking the multidimensional nature of eco-innovation (Gerged *et al*., 2024; Xu *et al*., 2025). In practice, eco-product, eco-process, and eco-organizational innovations impose distinct informational demands, and distinguishing them is essential for identifying which type is most sensitive to EMA signals, a question with both theoretical and managerial implications (Cheng & Shiu, 2012; Oduro, 2024).

Vietnam provides a fitting context for examining both questions simultaneously. SMEs account for over 97% of all active enterprises, contribute approximately 45% of GDP, and employ more than 60% of the workforce (Ministry of Planning and Investment, 2023). The 2020 Law on Environmental Protection tightened waste-declaration and emissions-monitoring obligations, and many SMEs participate in the supply chains of foreign-invested firms that require environmental data as a condition for order retention (Ngo, 2023; Liem & Hien, 2024). Empirical evidence on EMA in this segment remains thin and fragmented (Hoai *et al*., 2023; Huynh & Nguyen, 2024; Ngoc, 2025).

Taken together, no prior study has simultaneously disaggregated the three forms of institutional pressure and the three forms of eco-innovation within a single model for SMEs in a transition economy, leaving the precise mechanism that links external pressure, EMA adoption, and each form of eco-innovation unresolved. The study pursues two objectives. First, it assesses the distinct influence of each form of institutional pressure on EMA adoption. Second, it tests the effects of EMA on three forms of eco-innovation. In doing so, the study clarifies how accounting-based environmental information can be translated into concrete eco-innovation outcomes that reduce the pollution intensity and resource footprint of manufacturing activity, an applied environmental-management question of direct relevance to sustainability and ecosystem protection in transition economies. The paper makes three contributions: it disaggregates the three institutional isomorphic mechanisms, separates the three forms of eco-innovation to trace the mechanism of influence, and delivers evidence from a transition economy whose institutional context differs meaningfully from those studied most often.

Theoretical background and hypotheses

Integrated theoretical framework

The study rests on three complementary theoretical foundations. Institutional theory (DiMaggio & Powell, 1983) explains the first link in the causal chain: why firms within the same institutional field converge on similar management practices under three forms of isomorphic pressure. The natural-resource-based view (Hart, 1995) and the dynamic capabilities perspective (Teece *et al*., 1997) explain the second link: once established, EMA becomes an informational resource enabling firms to sense ecological inefficiencies, seize improvement opportunities, and reconfigure the organization to adapt. A recent systematic review confirms that EMA is increasingly applied to proactive strategic decision-making rather than mere regulatory compliance (Swalih *et al*., 2024). This integration positions EMA as both an outcome of the institutional environment and an antecedent of eco-innovation (Appannan *et al*., 2022; Asiaei *et al*., 2022).

Institutional pressures and EMA adoption

Coercive pressure originates from mandatory legal requirements and from powerful actors in the value chain on which the firm depends. In Vietnam, the 2020 Law on Environmental Protection requires waste declaration, emissions monitoring, and compliance with discharge standards, creating a direct incentive for firms to establish environmental data collection systems, which represent a core function of EMA. Requirements from lead customers to provide environmental data similarly compel smaller suppliers to develop measurement capabilities (Liem & Hien, 2024). Evidence from Vietnam, Pakistan, Egypt, and China consistently identifies coercive pressure as a strong predictor of EMA adoption (Wang *et al*., 2019; Chaudhry & Amir, 2020; Alnaim & Metwally, 2024; Cao *et al*., 2025).

H1: *Coercive pressure positively affects EMA adoption in manufacturing SMEs.*

Normative pressure is tied to professionalization and the spread of professional standards. Accounting education programs, professional associations, environmental accounting training, and transparency requirements from green finance systems are gradually shaping the expectation that a responsible firm should track and disclose environmental information (Kong *et al*., 2022; Alnaim & Metwally, 2024). Once internalized, firms regard EMA as an expression of professional legitimacy rather than a mere response to sanctions (Latan *et al*., 2018; Cao *et al*., 2025).

H2: *Normative pressure positively affects EMA adoption in manufacturing SMEs.*

Mimetic pressure arises when firms face uncertainty and emulate organizations perceived as successful. Notably, Wang *et al*. (2019) found no significant effect of mimetic pressure on EMA in China. In Vietnam, where EMA is still diffusing, this mechanism is likely to operate more modestly because pioneering firms are few and the benefits are not yet widely visible (Nureen *et al*., 2022; Ngo, 2023). Nevertheless, as some SMEs achieve clear gains in cost reduction or order retention, peer firms tend to follow, so a positive but moderate effect is expected.

H3: *Mimetic pressure positively affects EMA adoption in manufacturing SMEs.*

EMA and Eco-innovation

Eco-innovation is defined as the creation or improvement of products, processes, and organizational methods that reduce adverse environmental impact (Cheng & Shiu, 2012). Such activities require a quantitative information base on environmental impacts and their associated hidden costs, which EMA provides (Hart, 1995). The dynamic capabilities perspective adds a transformation mechanism: EMA data enable firms to sense inefficiencies and deploy innovative solutions that improve long-run financial performance (Teece *et al*., 1997; Farza *et al*., 2021). Gerged *et al*. (2024) provide evidence that EMA promotes eco-innovation, and Xu *et al*. (2025) identify distinct mediation pathways for process versus product innovation. The present study separates all three forms to examine the mechanism in finer detail.

For eco-product innovation, EMA information on life-cycle costs, material consumption, and product-level environmental liabilities supports designers in choosing more sustainable materials and improving the ecological profile of output (Al-Hanakta *et al*., 2023). However, product innovation also depends on market signals and research-and-development capability, factors beyond EMA's informational scope, so a moderate effect is expected.

H4: *EMA positively affects eco-product innovation (EPI).*

For eco-process innovation, physical data from EMA on energy and water consumption and waste volumes at each production stage allow managers to pinpoint inefficiencies and prioritize investment in process redesign or technological upgrading (Hanif et al., 2023). Because EMA is directly tied to material flows in production, its signals translate relatively readily into process-improvement actions.

H5: *EMA positively affects eco-process innovation (EPrI).*

For eco-organizational innovation, which encompasses establishing environmental procedures, assigning responsibilities, and building incentive systems oriented toward environmental goals, EMA provides a shared measurement language that embeds environmental criteria into internal governance systems (Hasan & Rahman, 2023; Sarango-Lalangui *et al*., 2023). Environmental cost information from EMA can directly persuade top management to assign responsibilities and adjust incentive structures, thereby promoting organizational innovation even before process or product changes occur (Oduro, 2024).

H6: *EMA positively affects eco-organizational innovation (EOI).*

Figure 1 presents the research model, depicting three forms of institutional pressure on EMA and from EMA to three forms of eco-innovation.

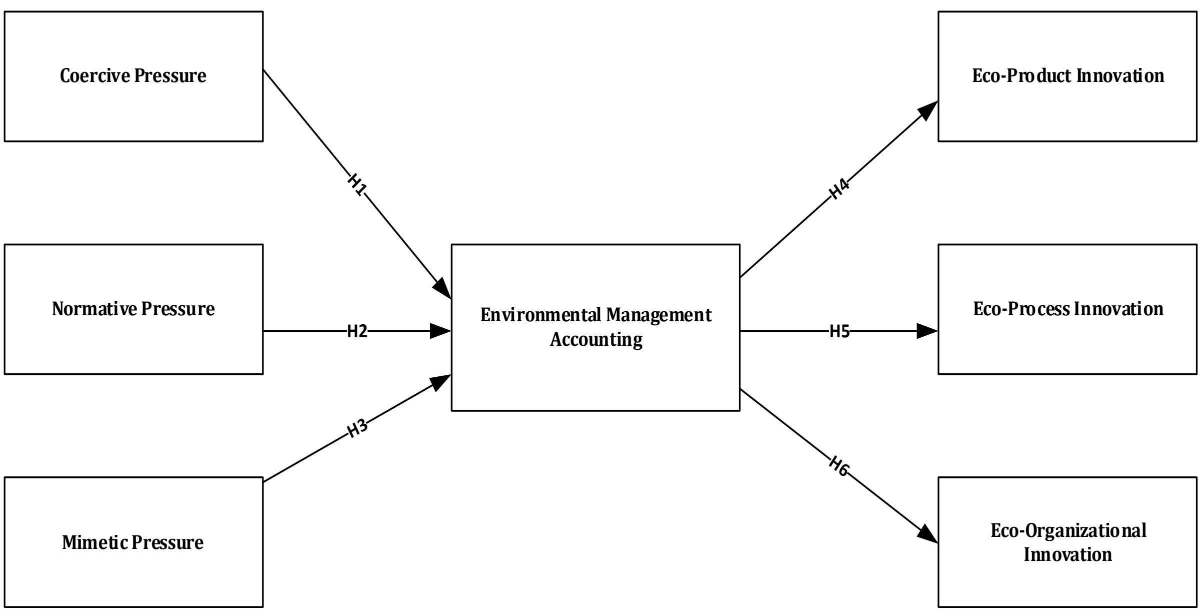

Figure 1. Proposed research model.

MATERIALS AND METHODS

Research design and data collection

The study uses a cross-sectional, quantitative design. The target population is manufacturing SMEs in Ho Chi Minh City, as defined by Decree 80/2021/ND-CP. Ho Chi Minh City was selected because it is Vietnam's largest industrial hub, where dense concentrations of manufacturing activity exert substantial pressure on local air, water, and soil quality, and where SMEs are directly subject to the waste-declaration and emissions-monitoring obligations of the 2020 Law on Environmental Protection. Focusing on this population, therefore, allows the study to capture environmental management behavior in a setting where the ecological stakes of SME manufacturing are most pronounced. To ensure that respondents were knowledgeable about both strategic orientation and financial and environmental information, the survey was administered to business owners or chief accountants. Participating firms had to have operated for at least three years, ensuring exposure to at least one environmental compliance cycle.

The questionnaire was finalized in two stages. First, validated English-language scales were translated into Vietnamese and independently back-translated by two bilingual experts to ensure semantic equivalence (Anh *et al*, 2026). Second, two accounting lecturers and three managers reviewed terminology and contextual appropriateness. Formal data were collected via convenience sampling. Of 350 questionnaires distributed, 247 usable responses were obtained after excluding incomplete or internally inconsistent forms, yielding a response rate of 70.6%, which exceeds the minimum recommended for PLS-SEM (Hair *et al*., 2019).

Measures

All latent constructs were measured on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree) and operationalized as reflective constructs. Institutional pressure comprised three components: coercive pressure (IP_CO, 4 indicators), normative pressure (IP_NO, 3 indicators), and mimetic pressure (IP_MI, 3 indicators), adapted from Wang *et al*. (2019) and Chaudhry and Amir (2020). EMA was measured with six indicators from Wang *et al*. (2019). The three forms of eco-innovation, EPI, EPrI, and EOI, each with three indicators, were measured using the widely validated scales of Cheng and Shiu (2012). Indicator codes, outer loadings, reliability, validity, and predictive relevance statistics, together with scale sources, are presented in **Table 2**.

Analytical approach

The model was estimated to use PLS-SEM in SmartPLS 4 (Ringle *et al*., 2022), appropriate given the study's combined explanatory and predictive objectives (Hair *et al*., 2019). The analysis followed two stages. The measurement model was first assessed via internal consistency reliability (Cronbach's alpha and composite reliability ρc), convergent validity (average variance extracted, AVE), discriminant validity (the heterotrait-monotrait ratio, HTMT), and multicollinearity (variance inflation factor, VIF). Out-of-sample predictive relevance was evaluated via the Q^2 index (Stone–Geisser) from a blindfolding procedure with an omission distance of 7. The structural model was then assessed through standardized path coefficients, the coefficient of determination R^2, effect sizes f^2, and statistical significance from bootstrapping with 5,000 resamples using bias-corrected confidence intervals.

Common method bias was controlled both through design measures, including respondent anonymity and varied item ordering, and through a full collinearity test following Kock (2015). All inner-model VIF values fell below 3.3, indicating that common method bias is not a serious concern (Podsakoff *et al*., 2003).

RESULTS AND DISCUSSION

Sample profile

Table 1 presents the sample profile. Of the 247 respondents, 168 (68.0%) were business owners and 79 (32.0%) were chief accountants. Both hold positions that give them access to the strategic and financial information the study requires. The firms varied in how long they had operated. Most had been in business for six to ten years (157 firms, 63.6%). A further 62 firms (25.1%) had operated for three to five years, and 28 (11.3%) for more than ten years. Several manufacturing branches were represented. Food and beverage were the most common (72 firms, 29.1%), followed by textile and garment (54 firms, 21.9%), mechanical and metal products (48, 19.4%), and chemicals, rubber, and plastics (39, 15.8%). The remaining 34 firms (13.8%) belonged to other branches.

Table 1. Sample profile of respondents and firms.

Characteristic	f	%
Respondent position		
Business owner	168	68.0
Chief accountant	79	32.0
Years in operation		
3–5 years	62	25.1
6–10 years	157	63.6
More than 10 years	28	11.3
Manufacturing subsector		
Food and beverage	72	29.1
Textile and garment	54	21.9
Mechanical and metal products	48	19.4
Chemicals, rubber, and plastics	39	15.8
Other	34	13.8

Note. f = frequency; % = percentage; N = 247.

Measurement model assessment

Table 2 presents the measurement model results. All outer loadings exceeded 0.708 (Hair *et al*., 2019), confirming indicator-level reliability. Cronbach's alpha ranged from 0.796 to 0.888, and composite reliability ρc ranged from 0.880 to 0.914, all exceeding 0.70, confirming internal consistency reliability. AVE values ranged from 0.641 to 0.764, all exceeding 0.50, confirming convergent validity. No indicator was removed, and EMA retained all six items. The Q^2 values for all endogenous constructs were positive (EMA = 0.190; EOI = 0.156; EPrI = 0.121; EPI = 0.050), confirming out-of-sample predictive relevance.

Table 2. Measurement model results: outer loadings, internal consistency, convergent validity, predictive relevance, and scale sources.

Construct	Item	Outer Loading	α	ρc	AVE	Q^2	Source
Coercive Pressure (IP_CO)	IP_CO1	0.816	0.843	0.894	0.679	-	Wang *et al*. (2019)
	IP_CO2	0.835					
	IP_CO3	0.811					
	IP_CO4	0.835					
Normative Pressure (IP_NO)	IP_NO1	0.823	0.796	0.88	0.709	-	Wang *et al*. (2019); Chaudhry and Amir (2020)
	IP_NO2	0.862					

	IP_NO3	0.84					
Mimetic Pressure (IP_MI)	IP_MI1	0.869	0.848	0.906	0.764	-	Chaudhry and Amir (2020)
	IP_MI2	0.901					
	IP_MI3	0.851					
Environmental Management Accounting (EMA)	EMA1	0.837	0.888	0.914	0.641	0.19	Wang *et al.* (2019)
	EMA2	0.776					
	EMA3	0.774					
	EMA4	0.831					
	EMA5	0.768					
	EMA6	0.814					
Eco-Product Innovation (EPI)	EPI1	0.866	0.827	0.897	0.743	0.05	Cheng and Shiu (2012)
	EPI2	0.878					
	EPI3	0.842					
Eco-Process Innovation (EPrI)	EPrI1	0.875	0.827	0.896	0.743	0.121	Cheng and Shiu (2012)
	EPrI2	0.853					
	EPrI3	0.858					
Eco-Organizational Innovation (EOI)	EOI1	0.873	0.821	0.893	0.736	0.156	Cheng and Shiu (2012)
	EOI2	0.858					
	EOI3	0.843					

Discriminant validity was assessed using the HTMT ratio **(Table 3)**, a more sensitive criterion than the Fornell-Larcker criterion (Fornell & Larcker, 1981; Henseler *et al.*, 2015). The highest HTMT value was 0.543, between EMA and EOI, and all values were below the accepted threshold of 0.85, confirming discriminant validity.

Table 3. Discriminant validity: HTMT ratios.

	IP_CO	IP_MI	IP_NO	EMA	EPI	EPrI	EOI
IP_CO	-						
IP_MI	0.357	-					
IP_NO	0.412	0.247	-				
EMA	0.538	0.349	0.468	-			
EPI	0.078	0.077	0.155	0.319	-		
EPrI	0.220	0.170	0.157	0.481	0.140	-	
EOI	0.278	0.104	0.190	0.543	0.167	0.193	-

Inner-model VIF values ranged from 1.12 to 1.21, well below the 3.3 threshold, ruling out multicollinearity among predictors. The SRMR of the estimated model was 0.056, below the 0.08 threshold, indicating acceptable overall model fit.

Structural model and hypothesis testing

The structural model explained 30.7% of the variance in EMA (R^2 = 0.307; adjusted R^2 = 0.298), 21.6% in EOI (adjusted R^2 = 0.213), 16.9% in EPrI (adjusted R^2 = 0.166), and 7.5% in EPI (adjusted R^2 = 0.071). Results from bootstrapping with 5,000 resamples are presented in **Table 4** and **Figure 2**. All six hypotheses were supported at $p \leq 0.005$, with bias-corrected 95% confidence intervals excluding zero. **Figure 2** illustrates the structural model results

Table 4. Structural model results.

H	Path	β	SD	t	p	95% CI	f^2	Decision
H1	IP_CO → EMA	0.334	0.056	6.012	< 0.001	[0.224, 0.440]	0.133	Supported
H2	IP_NO → EMA	0.254	0.053	4.759	< 0.001	[0.145, 0.351]	0.081	Supported
H3	IP_MI → EMA	0.157	0.056	2.815	0.005	[0.046, 0.263]	0.032	Supported
H4	EMA → EPI	0.274	0.064	4.262	< 0.001	[0.137, 0.390]	0.081	Supported
H5	EMA → EPrI	0.411	0.050	8.203	< 0.001	[0.303, 0.502]	0.203	Supported

H6	EMA → EOI	0.465	0.046	10.032	< 0.001	[0.364, 0.548]	0.275	Supported

Note. β = standardized path coefficient; SD = bootstrap standard deviation; CI = bias-corrected 95% confidence interval; f^2 = effect size (0.02 = small; 0.15 = medium; 0.35 = large). R^2 (adjusted R^2): EMA = 0.307 (0.298); EPI = 0.075 (0.071); EPrI = 0.169 (0.166); EOI = 0.216 (0.213). SRMR = 0.056. N = 247.

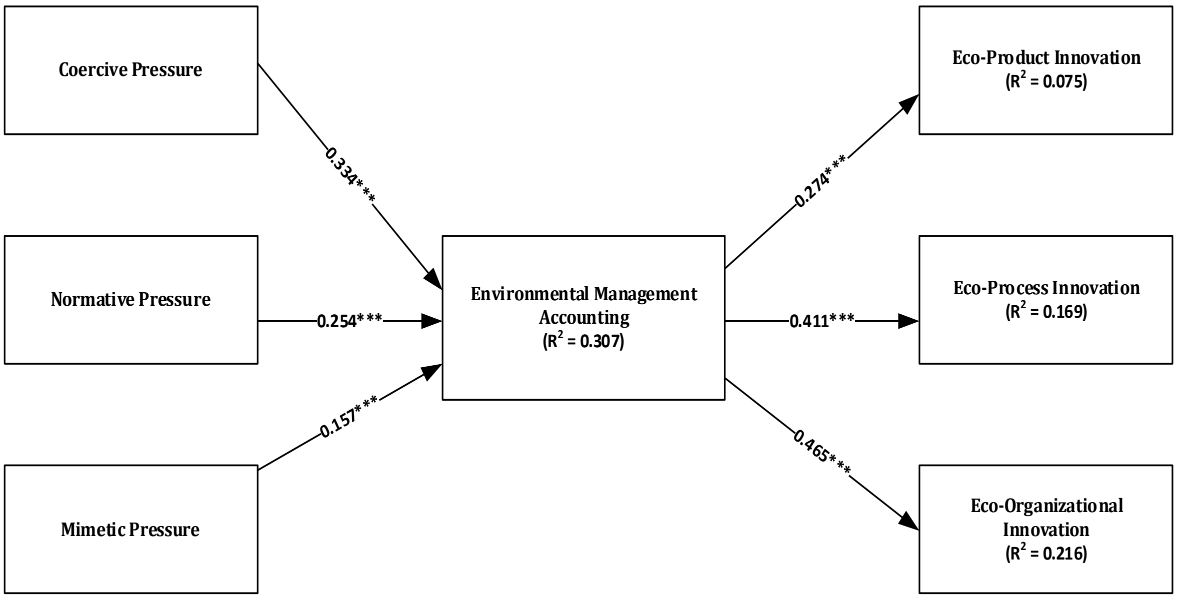

Figure 2. Structural model results.

All three forms of institutional pressure had positive and significant effects on EMA adoption, supporting H1, H2, and H3. Coercive pressure was the strongest driver (β = 0.334; f^2 = 0.133, a medium effect), consistent with findings from other transition economies (Chaudhry & Amir, 2020; Alnaim & Metwally, 2024; Cao *et al*., 2025). Under resource constraints, manufacturing SMEs prioritize compliance with specific, mandatory legal requirements, such as the waste-declaration obligation under the 2020 Law on Environmental Protection. Normative pressure was the second driver (β = 0.254; f^2 = 0.081), reflecting how the professionalization of accounting is gradually shaping expectations regarding environmental accounting practice (Hoai *et al*., 2023). Mimetic pressure had a modest but significant effect (β = 0.157; f^2 = 0.032, a small effect). This contrasts with Wang *et al*. (2019), who found no significant mimetic effect in China. The difference may reflect an early-stage diffusion dynamic in Vietnam, where pioneering firms are still few and their gains are not yet widely visible (Nureen *et al*., 2022; Ngo, 2023). Over time, the relative weight of normative and mimetic pressures is likely to grow, a proposition worth testing with longitudinal data.

EMA had positive and significant effects on all three forms of eco-innovation, supporting H4, H5, and H6, and reinforcing the proposition that EMA functions as an informational resource that activates eco-innovation (Hart, 1995; Gerged *et al*., 2024). The most striking finding is that EMA most strongly promoted organizational innovation (β = 0.465; f^2 = 0.275, a medium-to-large effect), rather than process innovation as initially expected. Viewed through the dynamic capabilities lens, environmental cost information made visible by EMA directly reveals to top management the scale of environmental responsibility, prompting restructuring of accountability assignments and internal incentive systems before the firm moves to process or product changes. In other words, organizational innovation is the most immediate managerial response to EMA information. This interpretation should nonetheless be approached with caution, because EMA is inherently a management system, and part of its strong association with organizational innovation may reflect conceptual proximity between the two constructs. Even so, the dynamic capabilities argument provides a consistent theoretical account of the observed hierarchy of effects.

The effect of EMA on process innovation (β = 0.411; f^2 = 0.203, medium-to-large) was substantial, consistent with the argument that physical EMA data translate relatively directly into process-improvement decisions (Hanif *et al*., 2023; Ngoc, 2025; Xia *et al*., 2025). The smallest effect was on product innovation (β = 0.274; f^2 = 0.081), with R^2 reaching only 7.5%, reflecting the reality that green product design depends heavily on market signals, research-and-development capability, and green supply-chain relationships that lie beyond EMA's informational scope. This finding aligns with Xu *et al*. (2025), who showed that supplier co-creation mediates process but not product innovation. The low R^2 for EPI is therefore a substantive finding, suggesting that EMA is a necessary but not sufficient condition for product eco-innovation.

In terms of theoretical contributions, the study extends the literature in three directions. First, disaggregating the three isomorphic mechanisms yields richer insight than collapsing them into a single construct, especially in the SME context of a transition economy (DiMaggio & Powell, 1983; Gunarathne *et al*., 2021). Second, integrating institutional theory with the natural-resource-based view and dynamic capabilities forms a comprehensive framework for both tiers of the causal chain (Hart, 1995; Teece *et al*., 1997). Third, the descending hierarchy of effects from organizational to process to product innovation provides a nuance not yet fully documented in the EMA literature, while contributing evidence from an under-represented developing economy (Huynh & Nguyen, 2024; Liem, 2025).

From an environmental-science perspective, the findings carry implications that extend beyond firm-level management. Because each form of eco-innovation examined here operates on a distinct environmental pathway, the observed effect hierarchy indicates where environmental gains are most likely to materialize first. Eco-organizational innovation embeds environmental responsibility, monitoring routines, and incentive structures into daily operations, creating the governance conditions under which pollution prevention becomes systematic rather than episodic. Eco-process innovation acts directly on the physical interface between the firm and the environment: by improving energy and water efficiency and reducing waste generation at each production stage, it lowers effluent loads, emissions, and demand for natural resources, thereby easing pressure on local air, water, and soil quality. Eco-product innovation, although the most constrained in this sample, contributes to sustainability along the entire product life cycle through greener material selection and reduced end-of-life environmental burdens. Taken together, the results suggest that strengthening environmental information systems in manufacturing SMEs is a scalable, low-cost pathway for reducing the aggregate pollution footprint of the industrial sector in transition economies, complementing regulatory enforcement in safeguarding ecosystems, biodiversity, and community health in rapidly industrializing regions such as Ho Chi Minh City.

CONCLUSION

The study tests a two-tier causal chain in manufacturing SMEs in Ho Chi Minh City, Vietnam, running from three forms of institutional pressure to EMA adoption and from EMA to three forms of eco-innovation. All six hypotheses were supported. Three findings shape the contribution: coercive pressure is the strongest driver of EMA adoption; EMA most strongly promotes organizational eco-innovation; and the effect hierarchy descends from organizational to process to product innovation. These findings suggest that EMA should be viewed not merely as a compliance tool but as an information platform capable of activating comprehensive eco-innovation at the firm level.

For managerial practice, firms should implement EMA along a pathway that prioritizes governance-oriented components first, such as establishing clear environmental responsibilities and redesigning performance-evaluation systems to incorporate environmental criteria, before expanding to process-level monitoring of energy consumption and waste volumes, thereby capitalizing on EMA's strongest effects. For policymakers, the effectiveness of coercive pressure confirms that mandatory environmental policies are on the right track. To move firms from formal compliance toward substantive eco-innovation, however, policies should simultaneously provide EMA technical guidance tailored to SME capacity, support environmental accounting training to reinforce normative pressure, and link environmental reporting requirements to green-credit programs (Zhen & Rahman, 2024).

Several limitations suggest avenues for future research. First, the cross-sectional design precludes causal inference over time and cannot rule out reverse causality or the influence of omitted variables such as top-management environmental commitment; longitudinal data are needed. Second, the baseline model excludes firm-level control variables, including size, age, ISO 14001 certification, and foreign ownership, that may affect both EMA adoption and innovation capacity, and their inclusion is a necessary robustness check. Third, all constructs rely on managerial self-reports; combining these with objective indicators such as verified emissions or actual environmental expenditures would enhance validity. Fourth, the medium R^2 for EMA (30.7%) and low R^2 for EPI (7.5%) indicate that additional factors, including digital transformation capability, research-and-development intensity, and green absorptive capacity, should be incorporated in future models. Finally, because the sample is confined to manufacturers in Ho Chi Minh City, caution is warranted in generalizing the results; cross-country comparisons among ASEAN nations would help test the robustness of the model across varying institutional contexts.

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CONFLICT OF INTEREST: None

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ETHICS STATEMENT: Participation was voluntary, all respondents provided written informed consent before the survey, and all data were collected anonymously. The study was approved by the Research Ethics Committee of the Industrial University of Ho Chi Minh City under Decision No. 296/QD-DHCN dated 24 February 2023.

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