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Environmental Management Policies, Green Innovation, and Sustainability Indicators: A PLS-SEM Investigation in Emerging Markets

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ABSTRACT

As environmental concerns intensify worldwide, organizations operating in emerging economies face growing pressure not only to formalize environmental management policies but also to implement them effectively. This study examines the sequential mechanism through which Environmental Management Policies (EMP) shape Sustainability Indicators (SI), mediated by Policy Implementation Effectiveness (PIE) and Green Innovation (GI), and moderated by Regulatory Pressure (RP) acting on the EMP–PIE relationship. Grounded in Institutional Theory, the Resource-Based View (RBV), and the Natural Resource-Based View (NRBV), we build an integrated conceptual model comprising nine hypotheses. Applying Partial Least Squares Structural Equation Modeling (PLS-SEM) to survey data collected from 312 managers at Vietnamese firms, we find support for all nine hypotheses. EMP substantially strengthens PIE ($\beta = 0.469$, $p < 0.001$) and exerts a direct effect on SI ($\beta = 0.294$, $p < 0.001$). PIE, in turn, drives GI ($\beta = 0.524$, $p < 0.001$), which further enhances SI ($\beta = 0.468$, $p < 0.001$). The serial mediation path through PIE and GI is also confirmed ($\beta = 0.115$, $p < 0.001$), and regulatory pressure is shown to amplify the EMP–PIE relationship ($\beta = 0.171$, $p < 0.001$). Collectively, the model accounts for 50.3% of the variance in SI. These results extend theory by distinguishing policy formulation from implementation effectiveness and provide practical guidance for policymakers and firm managers navigating sustainability transitions.

Keywords: *Environmental management policies, Policy implementation effectiveness, Green innovation, Sustainability indicators, Regulatory pressure, PLS-SEM*

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INTRODUCTION

Climate change, biodiversity loss, and resource depletion have accelerated to the point that environmental management has shifted from a peripheral compliance issue into a central strategic priority for organizations worldwide (Hart, 1995; Delmas & Toffel, 2008). This urgency is especially pronounced in emerging economies, where rapid industrialization produces substantial environmental externalities even as regulatory frameworks evolve in parallel, driven by both domestic pressures and international commitments such as the Paris Agreement and the United Nations Sustainable Development Goals (SDGs) (Peng *et al*., 2016). Vietnam illustrates this dynamic clearly: a manufacturing-intensive economy that has sustained annual GDP growth above 6% while pledging net-zero emissions by 2050, producing an institutional context in which the design and execution of Environmental Management Policies (EMP) take on heightened strategic importance.

Notwithstanding the extensive literature on environmental management, two notable gaps remain. First, most existing studies treat EMP as a binary construct—firms are classified as either having or lacking environmental policies—which overlooks the crucial distinction between policy formulation and Policy Implementation Effectiveness (PIE) (Bansal & Roth, 2000; Delmas & Toffel, 2008). Whether a formal policy is actually translated into operational change hinges on enforcement intensity, resource allocation, and monitoring systems, and it is precisely this gap that the present study theorizes and measures. Second, the pathways through which EMP contributes to sustainability outcomes—particularly via Green Innovation (GI) as an intervening organizational transformation—remain empirically underexplored, especially in settings where regulatory pressure from government bodies, industry standards, and stakeholders generates uneven incentives for implementation.

To address these gaps, this study develops and empirically tests a model in which PIE serves as the first-order mediator and GI as the second-order mediator in the EMP–Sustainability Indicators (SI) relationship, while Regulatory Pressure (RP) moderates the EMP–PIE linkage. From a theoretical standpoint, the model draws together Institutional Theory (DiMaggio & Powell, 1983), the Resource-Based View (Barney, 1991), and the Natural Resource-Based View (Hart, 1995) to account for how policy, organizational capability, and innovation jointly shape sustainability outcomes. Methodologically, PLS-SEM is used to estimate the direct, mediating, and moderating effects simultaneously within a single structural framework (Hair *et al*., 2019).

This study makes four specific contributions. First, it offers first empirical evidence that EMP and PIE are analytically distinct constructs with different antecedent roles. Second, it validates a novel serial mediation chain (EMP → PIE → GI → SI). Third, it shows that regulatory pressure moderates the EMP–PIE relationship, thereby specifying the institutional conditions under which policy formulation is converted into implementation. Fourth, it contributes empirical evidence from Vietnam as a fast-growing emerging economy, thereby broadening the cross-contextual generalizability of environmental management theory.

Literature review and hypothesis development

Theoretical foundations

This study draws on three theoretical lenses. Institutional Theory (DiMaggio & Powell, 1983) interprets EMP as an organizational response to coercive, mimetic, and normative pressures exerted by regulators, industry peers, and societal norms; within this lens, regulatory pressure operates as a coercive institutional force that shapes the degree to which EMP is translated into effective implementation systems (Delmas & Toffel, 2008). The Resource-Based View (RBV; Barney, 1991) conceptualizes PIE as a strategic resource, whereby the organizational routines, monitoring systems, and human capital embedded in effective policy implementation form rare, hard-to-imitate capabilities capable of generating competitive advantage through environmental differentiation. The Natural Resource-Based View (NRBV; Hart, 1995) extends the RBV by linking pollution-prevention and clean-technology capabilities—analogous to GI—to both firm performance and macro-level ecological sustainability, thereby completing the theoretical bridge to SI.

EMP and policy implementation effectiveness

Environmental Management Policies constitute the formal institutional scaffolding—standards, compliance procedures, performance targets, and audit systems—through which organizations signal their intent toward environmental stewardship (Buysse & Verbeke, 2003; Delmas & Toffel, 2008). Formulating a policy, however, does not by itself produce behavioral change; effective implementation instead requires that policies be enforced through dedicated resources, performance-monitoring systems, training programs, and management accountability structures (Delmas & Toffel, 2008). Firms with more systematically formulated EMP are better positioned to generate the organizational legitimacy, resource commitments, and accountability norms that, in turn, enable higher PIE. This reasoning aligns with institutional theory: when organizations formalize environmental commitments, they signal legitimacy to external stakeholders, which reinforces internal compliance behavior and channels resources toward effective implementation.

H1: EMP positively influences Policy Implementation Effectiveness.

EMP and sustainability indicators

In addition to the mediated pathway through PIE and GI, EMP may also affect SI directly, by establishing organizational norms, reporting systems, and resource commitments that curb environmental externalities independently of innovation outcomes. Environmental compliance systems and EMS certification, for instance, directly reduce emissions, improve waste management, and enhance resource efficiency—all components captured within the SI construct used here (Dyllick & Hockerts, 2002; Clarkson *et al*., 2011). The NRBV likewise supports a direct EMP–SI path, on the grounds that pollution-prevention practices embedded in formal policy systems can yield ecological improvements directly.

H2: EMP positively influences Sustainability Indicators.

PIE and green innovation

Effective policy implementation builds organizational capabilities—monitoring infrastructure, environmental knowledge stocks, and cross-functional coordination routines—that subsequently feed into green innovation (Chen *et al*., 2006; Chen & Chang, 2013). Specifically, PIE generates the organizational slack, technical knowledge, and managerial attention required for eco-product development, green process redesign, and clean-technology adoption. Firms with higher PIE tend to develop environmental absorptive capacity, that is, the ability to recognize, assimilate, and exploit environmental knowledge to produce innovation outcomes (Cohen & Levinthal, 1990). This capability-to-innovation logic is grounded in the NRBV, which treats pollution-prevention capabilities as precursors to more advanced clean-technology capabilities.

H3: Policy Implementation Effectiveness positively influences Green Innovation.

PIE and sustainability indicators

Policy implementation effectiveness improves sustainability outcomes directly, through several channels: systematic enforcement reduces instances of non-compliance, resources devoted to environmental monitoring allow emission exceedances to be identified and corrected in real time, and employee training embeds environmental behaviors into routine operational decisions (Delmas & Toffel, 2008). Consequently, organizations with strong PIE tend to exhibit superior environmental performance across the emissions, resource-efficiency, and social-responsibility dimensions captured in SI (Dyllick & Hockerts, 2002; Clarkson *et al*., 2011).

H4: PIE positively influences Sustainability Indicators.

Green innovation and sustainability indicators (H5)

Green innovation—encompassing eco-product development, eco-process redesign, and clean-technology adoption—directly improves sustainability outcomes by reducing production-stage environmental impacts, enabling circular material flows, and supporting low-carbon value chains (Chen *et al*., 2006; Chen & Chang, 2013). The NRBV regards clean-technology capabilities as the highest-order environmental capability, one that generates both competitive advantage and positive ecological externalities (Hart, 1995; Hart & Dowell, 2011). Empirical work further confirms that GI improves environmental performance across a range of emerging-economy contexts (Chen *et al*., 2006).

H5: Green Innovation positively influences Sustainability Indicators.

Mediation effects

H6 proposes that PIE mediates the EMP–SI relationship, such that formal policy commitments generate sustainability gains chiefly by triggering effective implementation mechanisms rather than through policy formulation as such (Delmas &

Toffel, 2008). H7 proposes that GI mediates the PIE–SI relationship, whereby implementation effectiveness is converted into sustainability outcomes mainly by catalyzing innovation processes that directly reduce ecological impacts (Chen *et al*., 2006; Chen & Chang, 2013). H8 proposes a serial mediation pattern (EMP → PIE → GI → SI), in which policy formulation lays the institutional foundation, implementation effectiveness converts policy into organizational capabilities, green innovation transforms these capabilities into ecological outputs, and sustainability indicators register the cumulative outcome. This serial mediation chain constitutes the study's central theoretical contribution, bringing institutional, capability, and innovation perspectives together into one unified process model.

H6: PIE mediates the EMP–SI relationship.

H7: GI mediates the PIE–SI relationship.

H8: PIE and GI serially mediate the EMP–SI relationship.

Moderating role of regulatory pressure

Institutional Theory identifies coercive pressure from government regulators, industry-standards bodies, and powerful stakeholders as a primary driver of organizational environmental behavior (DiMaggio & Powell, 1983; Delmas & Toffel, 2008). Under conditions of high regulatory pressure, EMP adoption tends to be accompanied by stronger institutional expectations of genuine implementation, generating both external monitoring and internal legitimacy pressures that accelerate the conversion of EMP into PIE. Under weak regulatory pressure, by contrast, EMP may remain largely ceremonial, formulated to project environmental legitimacy without prompting substantive investment in implementation. This moderation argument is consistent with Delmas and Toffel's (2008) finding that the particular institutional pressures a firm faces critically shape its environmental management practices.

H9: Regulatory Pressure positively moderates the EMP–PIE relationship, such that the positive effect of EMP on PIE is stronger when RP is high.

MATERIALS AND METHODS

Research design and contextual setting

A quantitative, cross-sectional survey design was adopted, in keeping with the hypothetico-deductive approach commonly used to test structural causal models in organizational research (Hair *et al*., 2019). Vietnam was chosen as the focal context for three reasons. First, it is among the fastest-growing economies in Southeast Asia, with manufacturing accounting for roughly 24% of GDP and generating considerable environmental externalities. Second, Vietnam's regulatory environment is currently in transition: the 2020 Law on Environmental Protection (LEP 2020) substantially tightened emissions standards, enforcement mechanisms, and corporate environmental-reporting requirements, thereby producing meaningful variation in regulatory pressure across firms and industries. Third, the combination of institutional transition, resource constraints, and ESG-driven market pressures makes Vietnam a well-suited empirical setting for examining how institutional forces shape the EMP–implementation–innovation–sustainability chain.

Sample and data collection

The target population consisted of senior and middle managers directly responsible for environmental management or strategic planning at Vietnamese firms registered with the Vietnam Chamber of Commerce and Industry (VCCI). A stratified random sampling procedure was applied across firm-size strata (small, medium, large), industry sectors (manufacturing, services, energy, construction), and geographic regions (North, Central, South Vietnam) to ensure representativeness across the key dimensions of organizational heterogeneity.

Data were collected between February and June 2024 by means of a structured, self-administered questionnaire, distributed both online and in person at selected industrial parks in Hanoi, Ho Chi Minh City, and Da Nang. Of the 412 questionnaires distributed, 338 were returned, for a response rate of 82.0%. After 26 incomplete or outlier responses were removed (identified through Mahalanobis distance screening), 312 valid observations remained. This sample size meets Hair *et al*.'s (2019) recommended minimum of 10 observations per indicator for stable PLS-SEM estimation and exceeds the threshold implied by the ten-times rule for the most complex structural path in the model.

Non-response bias was assessed using Armstrong and Overton's (1977) early-versus-late respondent procedure, and no significant differences emerged on key demographic variables (all $p > 0.05$). Common method bias was examined through Harman's single-factor test (the first unrotated factor accounted for 22.3% of variance, well below the 50% threshold) and a marker-variable approach; both confirmed that common method bias was within acceptable limits.

Measurement instruments

All constructs were operationalized as reflective, multi-item scales measured on a seven-point Likert scale (1 = Strongly Disagree; 7 = Strongly Agree). Environmental Management Policies (EMP; 5 items) and Regulatory Pressure (RP; 4 items) were adapted from Delmas and Toffel (2008) and DiMaggio and Powell (1983). Policy Implementation Effectiveness (PIE; 4 items) was developed by the research team by adapting Delmas and Toffel's (2008) EMP instrument to focus specifically on the enforcement, resource-allocation, monitoring, and training dimensions of environmental policy, thereby capturing its operationalization rather than its formulation—a theoretically motivated distinction not found in prior scales. Green Innovation (GI; 4 items) was adapted from Chen *et al*. (2006) and Chen and Chang (2013) and covers eco-product innovation, eco-process innovation, green-technology adoption, and environmental R&D investment. Sustainability Indicators (SI; 5 items) were adapted from Dyllick and Hockerts (2002) and the Global Reporting Initiative (GRI, 2021) and capture environmental (emissions, resource efficiency), economic (cost savings), and social (CSR impact, ecological balance) dimensions of sustainability.

The questionnaire was originally drafted in English, translated into Vietnamese by two bilingual academics, and then back-translated by a third, independent translator to verify equivalence. A pilot test involving 32 managers confirmed that the items were comprehensible and demonstrated preliminary reliability (Cronbach's $\alpha > 0.80$ for all constructs).

Analytical approach: PLS-SEM

PLS-SEM, implemented in SmartPLS 4.0 (Ringle *et al*., 2022), was chosen for three reasons. First, the research model is prediction-oriented and structurally complex, involving direct paths, two mediators arranged in series, and a moderation effect—conditions for which variance-based estimation is well suited (Hair *et al*., 2019). Second, PLS-SEM is robust to departures from multivariate normality. Third, it offers efficient estimation for samples of moderate size relative to model complexity.

The analysis followed Anderson and Gerbing's (1988) two-stage protocol. Stage 1 (the measurement model) evaluated outer loadings (threshold ≥ 0.70), composite reliability (CR ≥ 0.70), average variance extracted (AVE ≥ 0.50), and Heterotrait–Monotrait (HTMT) ratios (< 0.85) for discriminant validity (Henseler *et al*., 2015). Stage 2 (the structural model) examined path coefficients, t-statistics and p-values obtained from 5,000-iteration bootstrapping, R^2 values, predictive relevance (Q^2 via blindfolding, with an omission distance of 7), and effect sizes (f^2; Cohen, 1988). Mediation effects (H6–H8) were tested through bootstrapped confidence intervals for the indirect effects (Preacher & Hayes, 2008), while the moderation effect (H9) was tested using mean-centered product-indicator interaction terms (Hair *et al*., 2019).

RESULTS AND DISCUSSION

Respondent profile

Table 1 summarizes the sample profile. Male respondents made up 65.1% of the sample, and top and senior managers accounted for 45.5% of respondents. Medium-sized firms (50–299 employees) were the most represented category (44.2%). Manufacturing was the largest industry sector (32.7%), followed by services (26.9%) and energy and utilities (20.8%). Respondents' average organizational tenure was 8.9 years (SD = 4.1), supporting the assumption that they possessed adequate contextual knowledge of firm-level environmental management practices.

Table 1. Respondent Demographic Profile (N = 312)

Characteristic	Category	f	%
Gender	Male	203	65.1
	Female	109	34.9
Managerial Position	Top / Senior Manager	142	45.5
	Middle Manager	115	36.9
	Operational Manager	55	17.6
Firm Size	Small (<50 employees)	62	19.9
	Medium (50–299 employees)	138	44.2
	Large (≥300 employees)	112	35.9
Sector	Manufacturing	102	32.7
	Services	84	26.9
	Energy & Utilities	65	20.8
	Construction	38	12.2
	Other	23	7.4
Tenure	<5 years	71	22.8
	5–10 years	126	40.4
	>10 years	115	36.9

Note. f = Frequency; % = Percentage.

Measurement model assessment

Table 2 reports the measurement model results. All outer loadings fell between 0.764 and 0.814, exceeding the 0.70 threshold, while AVE values ranged from 0.612 to 0.631—all above 0.50—confirming convergent validity. CR values ranged from 0.883 to 0.894 and Cronbach's α from 0.847 to 0.860, both above 0.70, confirming internal consistency reliability. All indicator VIF values remained below 2.52, ruling out significant collinearity.

Table 2. Measurement Model: Loadings, AVE, CR, Cronbach's α, and VIF

Construct / Item	Load.	AVE	CR	α	VIF	Source
Environmental Management Policies (EMP)		0.624	0.891	0.857		Delmas and Toffel (2008)
EMP1 – Formal env. standards & procedures	0.791				2.28	
EMP2 – Environmental compliance policy	0.812				2.46	
EMP3 – Internal environmental rules	0.783				2.19	
EMP4 – Env. performance target-setting	0.796				2.33	
EMP5 – EMS certification and auditing	0.769				2.11	

Policy Implementation Effectiveness (PIE)		0.618	0.887	0.851		Authors, adapted from Delmas and Toffel (2008)
PIE1 – Degree of policy enforcement	0.784				2.21	
PIE2 – Resource allocation for env. goals	0.803				2.39	
PIE3 – Monitoring & evaluation systems	0.779				2.17	
PIE4 – Employee env. training programs	0.788				2.24	
Green Innovation (GI)		0.631	0.894	0.859		Chen *et al.* (2006); Chen and Chang (2013)
GI1 – Eco-product innovation	0.797				2.34	
GI2 – Eco-process innovation	0.814				2.51	
GI3 – Green technology adoption	0.788				2.27	
GI4 – Env. R&D investment	0.771				2.08	
Sustainability Indicators (SI)		0.628	0.893	0.860		Dyllick and Hockerts (2002); GRI (2021)
SI1 – Emission and waste reduction	0.794				2.31	
SI2 – Resource-use efficiency	0.809				2.44	
SI3 – Environmental cost savings	0.782				2.18	
SI4 – CSR and stakeholder impact	0.797				2.36	
SI5 – Long-run ecological balance	0.774				2.09	
Regulatory Pressure (RP)		0.612	0.883	0.847		DiMaggio and Powell (1983); Delmas and Toffel (2008)
RP1 – Government regulatory stringency	0.779				2.14	
RP2 – Industry environmental standards	0.793				2.27	
RP3 – Stakeholder env. expectations	0.786				2.21	
RP4 – Legal compliance requirements	0.764				2.01	

Note. AVE = Average Variance Extracted; CR = Composite Reliability; VIF = Variance Inflation Factor. All loadings significant at $p < 0.001$.

Table 3 reports the HTMT ratios used to assess discriminant validity. All values fell between 0.392 and 0.724, comfortably below the conservative 0.85 threshold (Henseler *et al.*, 2015). The Fornell–Larcker criterion was likewise satisfied for every construct pair, confirming adequate discriminant validity across the measurement model.

Table 3. Discriminant Validity: HTMT Ratios

Construct	EMP	PIE	GI	SI
EMP	—			
PIE	0.716	—		
GI	0.647	0.703	—	
SI	0.638	0.711	0.724	—
RP	0.418	0.457	0.392	0.431

Note. All HTMT values < 0.85 confirm discriminant validity (Henseler *et al.*, 2015). EMP = Environmental Management Policies; PIE = Policy Implementation Effectiveness; GI = Green Innovation; SI = Sustainability Indicators; RP = Regulatory Pressure.

Structural model and hypotheses testing

Tables 4 and 5 present the structural model results. R^2 values of 0.220 for PIE, 0.312 for GI, and 0.503 for SI indicate moderate-to-substantial explanatory power (Hair *et al.*, 2019). Q^2 values for all endogenous constructs exceeded zero (ranging from 0.134 to 0.316), confirming predictive relevance, while average f^2 values ranged from 0.128 to 0.214, indicating small-to-medium effect sizes (Cohen, 1988).

Table 4. Structural Model: Path Coefficients, Mediation, and Moderation Results

H	Relationship	β	S.E.	t-stat	p	Decision
H1	EMP → PIE	0.469	0.058	8.086	<.001	Supported
H2	EMP → SI	0.294	0.065	4.523	<.001	Supported
H3	PIE → GI	0.524	0.056	9.357	<.001	Supported
H4	PIE → SI	0.341	0.062	5.500	<.001	Supported
H5	GI → SI	0.468	0.057	8.211	<.001	Supported
H6	EMP→PIE→SI (mediation)	0.160	0.034	4.706	<.001	Supported

H7	PIE→GI→SI (mediation)	0.245	0.039	6.282	<.001	Supported
H8	EMP→PIE→GI→SI (serial)	0.115	0.029	3.966	<.001	Supported
H9	RP × EMP → PIE	0.171	0.046	3.717	<.001	Supported

Note. β = standardized path coefficient; S.E. = bootstrapped standard error (5,000 subsamples). All paths significant at $p < 0.001$.

Table 5. Model Fit Indicators: R^2, Q^2, and Effect Size (f^2)

Endogenous Construct	R^2	R^2 Adj.	Q^2	f^2 (avg.)
Policy Implementation Effectiveness (PIE)	0.220	0.217	0.134	0.128
Green Innovation (GI)	0.312	0.308	0.195	0.161
Sustainability Indicators (SI)	0.503	0.495	0.316	0.214

Note. R^2 benchmarks: 0.25 = moderate; 0.50 = substantial (Hair *et al.*, 2019). $Q^2 > 0$ = predictive relevance.

H1 was supported (β = 0.469, t = 8.086, $p < 0.001$), indicating that EMP significantly enhances PIE and confirming that formal policy infrastructure promotes effective implementation. This result corroborates Delmas and Toffel (2008), who identify policy formalization as a necessary precondition for substantive environmental management practice. H2 was also supported (β = 0.294, t = 4.523, $p < 0.001$), confirming a direct EMP–SI pathway that operates independently of the mediated route, consistent with the NRBV argument that pollution-prevention policies can directly yield ecological gains (Hart, 1995).

H3 (PIE → GI: β = 0.524, t = 9.357, $p < 0.001$) produced the strongest direct structural path in the model, underscoring implementation effectiveness as the primary upstream driver of green innovation. This finding extends Chen *et al.*'s (2006) work by showing that the organizational capability base built through policy implementation—monitoring systems, environmental knowledge, and trained personnel—represents the critical precondition for innovation. H4 (PIE → SI: β = 0.341, t = 5.500, $p < 0.001$) was supported, confirming that effective implementation reduces environmental externalities directly, over and above its innovation-mediated effects. H5 (GI → SI: β = 0.468, t = 8.211, $p < 0.001$) was likewise supported, in line with Chen and Chang (2013) and Hart and Dowell (2011).

Regarding the mediation effects, H6 (EMP → PIE → SI: β = 0.160, 95% CI [0.099, 0.223]) was supported, indicating partial complementary mediation. H7 (PIE → GI → SI: β = 0.245, 95% CI [0.166, 0.327]) was likewise supported, with GI partially mediating the effect of PIE on SI, confirming that implementation effectiveness is translated into sustainability outcomes both directly and through innovation. H8, the serial mediation hypothesis (EMP → PIE → GI → SI: β = 0.115, 95% CI [0.064, 0.170]), was also confirmed. Although smaller than the individual indirect effects, this serial indirect effect was statistically significant and substantively meaningful, capturing the integrated capability-building chain that lies at the heart of the study's theoretical argument.

H9 (RP × EMP → PIE: β = 0.171, t = 3.717, $p < 0.001$) was supported. The interaction plot shows that the positive slope linking EMP to PIE is steeper when RP is one standard deviation above the mean than when it is one standard deviation below, confirming that regulatory pressure amplifies the EMP–PIE conversion. This finding lends empirical support to DiMaggio and Powell's (1983) logic of coercive isomorphism: under high institutional enforcement pressure, formal environmental policy commitments are more likely to translate into substantive implementation investment rather than remaining merely ceremonial.

Theoretical and practical discussion

The confirmed model advances environmental management theory in three important ways. First, by empirically distinguishing EMP from PIE as conceptually and empirically separate constructs—a distinction largely absent from prior research—this study shows that the EMP–sustainability relationship is fundamentally mediated by implementation quality rather than by policy content as such. This has notable theoretical implications: prior research may have overstated direct EMP–performance effects by conflating formulation with implementation, and future studies should routinely measure both dimensions separately.

Second, the confirmed serial mediation chain (EMP → PIE → GI → SI) brings together three theoretical traditions—institutional, capability, and innovation-based—within a single, empirically validated process model. This integration answers calls in the sustainability literature for multi-theory frameworks linking micro-organizational processes to macro-level ecological outcomes (Hart, 1995; Dyllick & Hockerts, 2002). More specifically, it shows that institutional stimuli (policy formalization under regulatory pressure) generate capability investments (PIE), which activate innovation processes (GI) that, in turn, produce measurable ecological outcomes (SI).

Third, the moderation result (H9) enriches institutional theory by specifying a boundary condition on the EMP–PIE relationship: regulatory pressure functions not merely as a driver of policy adoption but as an amplifier of policy operationalization—a more nuanced institutional mechanism with clear practical relevance for policymakers designing incentive-compatible environmental governance frameworks. For firm managers, the R^2 of 0.503 obtained for SI—the highest explanatory value in the study—shows that the EMP–PIE–GI chain accounts for more than half of the variance in SI, supporting a well-grounded prescription: invest in policy formalization, secure implementation resources, and cultivate green innovation as parts of a single, integrated environmental management system. For policymakers in Vietnam and similar emerging economies, the findings support regulatory intensification as a lever for strengthening the EMP–PIE conversion, suggesting that stronger enforcement mechanisms—inspections, penalties, and public disclosure requirements—would yield disproportionate sustainability gains from existing policy frameworks.

CONCLUSION

This study developed and empirically validated a model linking Environmental Management Policies to Sustainability Indicators through Policy Implementation Effectiveness and Green Innovation, with Regulatory Pressure serving as a boundary-condition moderator. Based on PLS-SEM analysis of survey data from 312 Vietnamese firms, all nine hypotheses were supported: EMP enhances PIE ($\beta = 0.469$) and directly influences SI ($\beta = 0.294$); PIE drives both GI ($\beta = 0.524$) and SI ($\beta = 0.341$); GI improves SI ($\beta = 0.468$); and the serial mediation chain EMP → PIE → GI → SI is confirmed ($\beta = 0.115$). Regulatory pressure amplifies the EMP–PIE relationship ($\beta = 0.171$), and the model as a whole explains 50.3% of the variance in sustainability indicators.

These findings carry meaningful theoretical and managerial implications. Theoretically, the study advances the environmental management literature by establishing PIE as a distinct mediating construct that separates policy formulation from sustainability outcomes, thereby resolving a long-standing conceptual ambiguity. Practically, the results suggest that managers should treat policy implementation as a primary lever: investment in enforcement systems, performance monitoring, and staff training generates first-order returns in GI and second-order gains in SI that exceed what policy formulation alone can achieve. Policymakers, for their part, should strengthen regulatory intensity to maximize the rate at which EMP is converted into PIE.

Several limitations point to directions for future research. First, the cross-sectional design constrains causal inference; longitudinal studies tracking the EMP–PIE–GI–SI chain over time would strengthen claims of causality. Second, the single-country sample limits cross-national generalizability, so future work should replicate the model across other ASEAN emerging economies that differ in regulatory intensity. Third, digital environmental management—including AI-enabled compliance monitoring and IoT-based emissions tracking—may act as an additional moderator or pathway amplifier, and incorporating digital transformation as a complementary variable would be a valuable extension. Fourth, disaggregating institutional pressure into its coercive, mimetic, and normative components as distinct moderating forces would enrich the application of institutional theory and yield more granular policy guidance.

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