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Investigating the Role of Environmental Management Systems in Enhancing Competitive Advantage and Mitigating Organizational Environmental Risks

Nguyen Tan Trung[1], Nguyen Thi Thuy Quynh[2*]

[1]School of Management, University of Economics Ho Chi Minh City, Ho Chi Minh City, Vietnam.
[2]Faculty of Fundamental Studies, Academy of Finance, Ha Noi, Vietnam.

ABSTRACT

Environmental Management Systems (EMS) have attracted considerable scholarly attention, yet their simultaneous contribution to competitive advantage and to environmental risk mitigation—a dual-outcome perspective—remains largely unexamined. This study develops and empirically tests an integrated model linking EMS to Competitive Advantage (CA) and Environmental Risk Mitigation (ERM) through the mediating role of Green Operational Capabilities (GOC), while treating Environmental Dynamism (ED) as a boundary-condition moderator. Grounded in the Natural Resource-Based View (NRBV), Dynamic Capabilities Theory (DCT), and Risk Management Theory, we formulate eleven hypotheses spanning direct effects, serial mediation, and moderation. Using Partial Least Squares Structural Equation Modeling (PLS-SEM) on survey data from 312 managers across Vietnamese manufacturing and service firms, we find support for all eleven hypotheses. EMS significantly predicts GOC ($\beta = 0.481$), CA ($\beta = 0.317$), and ERM ($\beta = 0.271$); GOC in turn strengthens both CA ($\beta = 0.451$) and ERM ($\beta = 0.364$), while CA further advances ERM ($\beta = 0.489$). Serial mediation through GOC and CA is confirmed ($\beta = 0.106$), and environmental dynamism amplifies the EMS–GOC relationship ($\beta = 0.157$). The model accounts for 53.4% of the variance in ERM. Taken together, these findings bridge sustainability, competitive strategy, and organizational risk management, contributing to both NRBV theory and sustainability practice in emerging economies.

Keywords: *Environmental management systems, Green operational capabilities, Competitive advantage, Environmental risk mitigation, Environmental dynamism, PLS-SEM*

Corresponding author: Nguyen Thi Thuy Quynh
e-mail ✉ nguyenthithuyquynh@hvtc.edu.vn
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INTRODUCTION

The accelerating pace of environmental degradation, combined with increasingly stringent regulatory frameworks and mounting stakeholder demand for corporate ecological accountability, has turned environmental management from a compliance obligation into a core strategic imperative (Hart, 1995; Erauskin-Tolosa *et al.*, 2020). Within this context, Environmental Management Systems (EMS)—systematic organizational frameworks for identifying, monitoring, and reducing environmental impacts, epitomized by the ISO 14001 standard—have become among the most widely adopted voluntary management tools worldwide, with more than 400,000 certified organizations across over 170 countries (ISO, 2022). Vietnam illustrates this emerging-economy trajectory well: its manufacturing-intensive growth model has generated escalating environmental externalities, while regulatory shifts aligned with COP26 commitments and a strengthened Law on Environmental Protection (LEP 2020) have substantially raised both regulatory pressure and the strategic salience of environmental management.

Despite this proliferation, the EMS literature exhibits a notable theoretical gap: most studies treat EMS solely as a driver of environmental or financial performance, overlooking its dual-outcome nature (Aragón-Correa & Sharma, 2003; Erauskin-Tolosa *et al.*, 2020). Strategically, EMS generates value through two distinct pathways—value creation (competitive advantage) and risk reduction (environmental risk mitigation)—and conflating them yields an incomplete, potentially misleading picture of EMS efficacy. Moreover, the organizational mechanism through which EMS translates into these dual outcomes—namely, Green Operational Capabilities (GOC) as an intermediate capability-building stage—has been theorized (Sharma & Vredenburg, 1998) but never empirically validated within a unified structural model.

This study addresses these gaps by developing an integrated model linking EMS → GOC → CA → ERM, with Environmental Dynamism (ED) specified as a moderator. The model draws on three complementary theoretical perspectives: the Natural Resource-Based View (NRBV; Hart, 1995), which frames EMS-generated capabilities as sources of competitive advantage; Dynamic Capabilities Theory (DCT; Teece *et al.*, 1997), which explains how green capabilities enable adaptation under environmental dynamism; and Risk Management Theory (Teece, 2007), which treats ERM as a firm-level outcome of systematic environmental capability deployment. Using PLS-SEM on data from 312 Vietnamese firms, we test eleven hypotheses and offer four contributions: (1) the first empirical validation of a dual-outcome (CA + ERM) EMS framework; (2) evidence that GOC is the capability-based mechanism bridging EMS and its dual outcomes; (3) confirmation of serial mediation

(EMS → GOC → CA → ERM); and (4) evidence that environmental dynamism amplifies the EMS–GOC relationship in an emerging-economy setting.

Literature review and hypothesis development

Theoretical foundations

The Natural Resource-Based View (NRBV; Hart, 1995) provides the primary theoretical scaffold, holding that firms which develop pollution-prevention and clean-technology capabilities—cultivated directly through EMS—generate resources that are rare, inimitable, and socially complex, and thus competitively valuable. Extending RBV into the ecological domain, Hart (1995) positions green process capabilities as sources of sustained competitive advantage through cost reduction, product differentiation, and reputational capital. Dynamic Capabilities Theory (DCT; Teece *et al*., 1997; Teece, 2007) complements NRBV by explaining how firms sense, seize, and reconfigure environmental resources as conditions change: EMS supplies the organizational routines and monitoring infrastructure through which dynamic environmental capabilities are built and deployed. Risk Management Theory contributes a third lens, positioning ERM as a distinct organizational outcome of systematic capability investment: the routines embedded in EMS, and operationalized through GOC, enable proactive identification, assessment, and reduction of environmental risk (Aragón-Correa & Sharma, 2003).

EMS and green operational capabilities (H1)

EMS supplies the institutional scaffolding—ISO 14001 certification frameworks, environmental procedures, monitoring systems, and continuous improvement protocols—through which environmental responsibility becomes systematically embedded in operational decision-making (Erauskin-Tolosa *et al*., 2020). The NRBV holds that this embedding fosters distinctive organizational capabilities: firms with formal EMS become better able to optimize resource flows, minimize waste, and redesign processes for ecological efficiency—collectively constituting GOC (Hart, 1995; Sharma & Vredenburg, 1998). Empirically, Erauskin-Tolosa *et al*.'s (2020) meta-analysis of 53 studies confirms that ISO 14001 certification is positively associated with green operational improvements, while Sharma and Vredenburg (1998) provide foundational case-based evidence that proactive environmental strategies generate unique organizational capabilities with competitive implications.

H1: EMS positively influences Green Operational Capabilities.

EMS and competitive advantage (H2)

Beyond its mediated pathway through GOC, EMS can generate competitive advantage directly, through several mechanisms: avoidance of regulatory compliance costs, green branding that differentiates products in ESG-conscious markets, access to preferential public procurement, and reputational signaling that attracts environmentally sensitive customers, partners, and investors (Barney, 1991; Aragón-Correa, 1998). Porter's (1985) competitive advantage framework identifies environmental efficiency as a cost-reduction lever that reinforces cost leadership, while environmental differentiation strategies enabled by EMS certification confer market-positioning advantages. Aragón-Correa (1998) provides empirical evidence that firms pursuing proactive environmental strategies build strategic assets that translate into competitive differentiation.

H2: EMS positively influences Competitive Advantage.

EMS and environmental risk mitigation (H3)

EMS frameworks are explicitly designed to identify, assess, and control environmental risks through systematic monitoring, compliance management, and corrective-action protocols (ISO 14001:2015). By embedding environmental risk assessment into strategic planning cycles, EMS allows firms to address regulatory compliance risks, pollution liability exposures, and supply chain environmental vulnerabilities proactively, before they escalate into costly incidents (Erauskin-Tolosa *et al*., 2020). Risk Management Theory supports a direct EMS–ERM relationship: the risk-governance structures established through EMS produce first-order risk-reduction benefits that are independent of the capability-building and competitive-advantage pathways.

H3: EMS positively influences Environmental Risk Mitigation.

GOC and competitive advantage (H4)

Green Operational Capabilities—encompassing green process efficiency, waste-reduction capability, and resource-optimization routines—generate competitive advantage through several channels consistent with both the NRBV and Porter's (1985) competitive strategy framework. Efficiency gains from GOC translate directly into cost-leadership advantages by lowering material input costs, energy expenditure, and waste-disposal expenses. At the same time, GOC supports differentiated market positioning through demonstrably greener production systems that command price premiums and gain access to ESG-sensitive market segments. Sharma and Vredenburg (1998) provide foundational evidence linking proactive environmental capability development to competitive outcomes, while Aragón-Correa and Sharma (2003) extend this logic by showing that dynamic environmental capabilities generate stronger competitive effects under conditions of environmental complexity.

H4: Green Operational Capabilities positively influence Competitive Advantage.

GOC and environmental risk mitigation (H5)

GOC—particularly waste-reduction capability, resource-optimization routines, and environmental learning and adaptation—reduces organizational environmental risk directly by improving operational environmental performance and lowering the probability and severity of environmental incidents (Hart, 1995; Teece *et al*., 1997). Firms with superior GOC possess deeper environmental monitoring capabilities, faster corrective-response systems, and more robust supply chain environmental controls, all of which attenuate compliance risk, pollution liability, and regulatory penalties. DCT specifically holds that dynamic environmental capabilities allow firms to reconfigure resources in response to emerging environmental threats, thereby reducing exposure to regulatory and physical environmental risks.

H5: Green Operational Capabilities positively influence Environmental Risk Mitigation.

Competitive advantage and environmental risk mitigation (H6)

Competitive advantage strengthens ERM through three interconnected mechanisms. First, cost and differentiation advantages generate the financial slack needed to sustain investment in environmental risk-management systems, monitoring infrastructure, and compliance-assurance programs (Porter, 1985; Barney, 1991). Second, green market reputation—a core component of environmental competitive advantage—fosters organizational commitment to maintaining environmental standards, creating internal pressure to manage proactively any risks that could damage reputational assets. Third, the regulatory first-mover advantages that accompany EMS-based competitive positioning typically involve deeper regulatory relationships and institutional goodwill, which favor proactive over reactive risk governance. Stakeholder theory reinforces this linkage: firms with stronger environmental competitive positions face heightened stakeholder scrutiny, which incentivizes more rigorous investment in risk mitigation.
H6: Competitive Advantage positively influences Environmental Risk Mitigation.

Mediation effects: GOC and CA (H7–H10)

H7 posits that GOC mediates the EMS → CA relationship: EMS generates competitive advantage primarily by building green operational capabilities that convert policy commitments into market-facing performance differentiators (Sharma & Vredenburg, 1998). H8 posits that GOC mediates EMS → ERM: EMS translates into risk mitigation mainly through the capability-building process it activates, rather than through policy formulation per se—consistent with the operationalization logic developed in implementation-effectiveness research. H9 posits that CA mediates GOC → ERM: capability-driven competitive advantage generates the financial and reputational resources that fund, and incentivize, deeper investment in risk mitigation (Waddock & Graves, 1997). H10 posits full serial mediation (EMS → GOC → CA → ERM), representing the study's primary theoretical contribution: a sequential capability-and-advantage-building pathway in which each stage is a necessary precondition for the next.
H7: GOC mediates the relationship between EMS and CA.
H8: GOC mediates the relationship between EMS and ERM.
H9: CA mediates the relationship between GOC and ERM.
H10: GOC and CA serially mediate the relationship between EMS and ERM.

Moderating role of environmental dynamism (H11)

Environmental dynamism—the rate and unpredictability of change in market conditions, regulatory frameworks, and environmental technology—creates conditions under which the capability-building value of EMS investment is amplified (Aragón-Correa & Sharma, 2003; Teece, 2007). Under high dynamism, organizations confront rapidly shifting compliance requirements, technological disruption of existing environmental processes, and volatile stakeholder expectations—conditions under which EMS supplies a disproportionately valuable sensing-and-reconfiguring infrastructure that accelerates GOC development. This reasoning is consistent with DCT: the strategic value of dynamic capabilities rises in more turbulent environments, as the ability to rapidly reconfigure environmental processes becomes a critical capability for both survival and performance.
H11: Environmental Dynamism positively moderates the EMS–GOC relationship, such that the positive effect of EMS on GOC is stronger when ED is high.

MATERIALS AND METHODS

Research design and contextual rationale

This study adopts a quantitative, cross-sectional survey design grounded in the hypothetico-deductive tradition appropriate for testing structural causal models (Hair *et al*., 2019). Vietnam was selected as the empirical setting for three theoretically motivated reasons. First, as a lower-middle-income economy with a manufacturing-intensive growth model, Vietnam displays substantial variation in EMS adoption maturity: both ISO 14001-certified and non-certified firms are present in numbers sufficient to generate the empirical heterogeneity required for PLS-SEM estimation. Second, Vietnam's strengthened Law on Environmental Protection (LEP 2020) and its intensified enforcement mechanisms have created a dynamic regulatory environment, generating meaningful variation in perceived environmental dynamism across firms and sectors. Third, Vietnam's strategic position within global supply chains—particularly in electronics, textiles, and agri-food—means that international customers' environmental requirements add further institutional incentives for EMS adoption, making it a setting in which the dual-outcome effects of EMS (competitive advantage and risk mitigation) are highly salient.

Sample and data collection

The target population comprised senior and middle managers holding direct environmental-management or strategic-planning responsibilities at Vietnamese firms registered with the Vietnam Chamber of Commerce and Industry (VCCI). Stratified random sampling was applied across firm size (small, medium, large), industry sector (manufacturing, energy, services, construction), and geographic region (North, Central, South Vietnam) to ensure representative diversity across key organizational characteristics, with particular attention to including both ISO 14001-certified and non-certified firms so as to capture variation in EMS maturity.
Data were collected between March and August 2023 using a structured, self-administered questionnaire distributed through an online survey platform and in-person administration at industrial parks in Hanoi, Ho Chi Minh City, and Da Nang. Of 418 questionnaires distributed, 341 were returned (response rate: 81.6%). After removing 29 incomplete or outlier responses identified through Mahalanobis distance analysis, 312 valid observations remained for analysis—a sample size that meets Hair *et al*.'s (2019) recommended minimum for the model's structural complexity and exceeds the ten-times-rule threshold for the most complex path in the structural model.
Non-response bias was assessed using Armstrong and Overton's (1977) early-versus-late respondent comparison on key demographic and construct variables; no significant differences emerged (all $p > 0.05$). Common method bias was evaluated through Harman's single-factor test—the first

unrotated factor accounted for 21.6% of variance, well below the 50% threshold—together with a full-collinearity VIF assessment, both confirming acceptable levels (Kock, 2015).

Measurement instruments

All constructs were measured on seven-point Likert scales (1 = Strongly Disagree; 7 = Strongly Agree) using multi-item reflective indicators. Environmental Management Systems (EMS; 5 items) was adapted from Erauskin-Tolosa *et al.*'s (2020) meta-analytic synthesis of ISO 14001 EMS components and from Aragón-Correa's (1998) environmental strategy scale, covering ISO 14001 adoption, environmental procedures, monitoring systems, continuous improvement protocols, and internal auditing. Green Operational Capabilities (GOC; 4 items) was adapted from Sharma and Vredenburg (1998) and Hart (1995), capturing green process efficiency, waste-reduction capability, resource optimization, and environmental learning and adaptation. Competitive Advantage (CA; 4 items) was adapted from Porter (1985) and Barney (1991), covering cost advantage, differentiation, green market reputation, and regulatory first-mover advantage. Environmental Risk Mitigation (ERM; 5 items) was developed by the research team based on Aragón-Correa and Sharma (2003) and the risk-assessment requirements of ISO 14001:2015, capturing risk identification, compliance risk control, pollution liability reduction, regulatory penalty avoidance, and supply chain environmental risk management. Environmental Dynamism (ED; 4 items) was adapted from Aragón-Correa and Sharma (2003), covering market volatility, technological change intensity, regulatory change frequency, and shifts in stakeholder environmental pressure.

The questionnaire was developed in English and translated into Vietnamese by two bilingual academics, with a third, independent translator performing back-translation to verify equivalence. A pilot test with 35 managers confirmed item comprehensibility and preliminary reliability (all Cronbach's $\alpha > 0.79$).

Analytical approach

PLS-SEM was implemented in SmartPLS 4.0 (Ringle *et al.*, 2022). It was preferred over covariance-based SEM for three reasons: (1) the research model is prediction-oriented, with a complex eleven-hypothesis structure spanning direct, mediation, and moderation paths; (2) PLS-SEM is robust to non-normal data distributions; and (3) it offers efficient estimation for moderate-to-large samples under structural complexity (Hair *et al.*, 2019). Analysis followed Anderson and Gerbing's (1988) two-step protocol. Stage 1 (measurement model) assessed outer loadings (≥ 0.70), composite reliability ($CR \geq 0.70$), average variance extracted ($AVE \geq 0.50$), and Heterotrait-Monotrait (HTMT) ratios (< 0.85; Henseler *et al.*, 2015) for discriminant validity. Stage 2 (structural model) examined path coefficients, bootstrapped t-statistics and p-values (5,000 subsamples), R^2, Q^2 (blindfolding, omission distance d = 7), and Cohen's (1988) effect sizes (f^2). Mediation effects (H7–H10) were tested via bootstrapped 95% confidence intervals for indirect effects (Preacher & Hayes, 2008), and the moderation effect (H11) was tested using mean-centered interaction terms following Hair *et al.*'s (2019) product-indicator approach.

RESULTS AND DISCUSSION

Respondent profile

Table 1 summarizes the sample profile. Male respondents made up 63.8% of the sample, and top and senior managers accounted for 44.2%. Medium-sized firms (50–299 employees) were the most represented category (44.6%). Manufacturing was the largest sector (34.3%), followed by services (24.7%) and energy & utilities (21.8%). Notably, 63.5% of respondents reported that their firms held ISO 14001 certification or an equivalent EMS framework, reflecting the relative maturity of EMS adoption within Vietnam's export-oriented industrial sector. Average organizational tenure was 9.1 years (SD = 3.8), supporting respondents' contextual competence to evaluate firm-level EMS and risk-management practices.

Table 1. Respondent Demographic Profile (N = 312)

Characteristic	Category	f	%
Gender	Male	199	63.8
	Female	113	36.2
Position	Top/Senior Manager	138	44.2
	Middle Manager	122	39.1
	Operational Manager	52	16.7
Firm Size	Small (<50 employees)	58	18.6
	Medium (50–299)	139	44.6
	Large (≥300)	115	36.9
Industry Sector	Manufacturing	107	34.3
	Energy & Utilities	68	21.8
	Services	77	24.7
	Construction	35	11.2
	Other	25	8.0
Tenure	<5 years	69	22.1
	5–10 years	124	39.7
	>10 years	119	38.1
EMS/ISO 14001	Certified	198	63.5

	Not Certified	114	36.5

Note. f = Frequency; % = Percentage.

Measurement model evaluation

Table 2 reports the measurement model results. Outer loadings ranged from 0.763 to 0.819, all above the 0.70 threshold. AVE values ranged from 0.611 to 0.634, all exceeding the 0.50 criterion and thus confirming convergent validity. Composite reliability (CR) ranged from 0.882 to 0.896, and Cronbach's alpha from 0.844 to 0.861, both above the 0.70 benchmark and confirming internal consistency reliability. All indicator VIF values fell below 2.58, ruling out collinearity concerns (Hair *et al*., 2019).

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

Construct / Indicator	Load.	AVE	CR	α	VIF	Source
Environmental Management Systems (EMS)		0.627	0.893	0.857		Erauskin-Tolosa *et al*. (2020); Aragón-Correa (1998)
EMS1 – ISO 14001 adoption & certification	0.794				2.31	
EMS2 – Env. procedures and standards	0.811				2.47	
EMS3 – Environmental monitoring systems	0.782				2.19	
EMS4 – Continuous improvement protocols	0.797				2.36	
EMS5 – Internal environmental auditing	0.771				2.12	
Green Operational Capabilities (GOC)		0.634	0.896	0.861		Sharma and Vredenburg (1998); Hart (1995)
GOC1 – Green process efficiency	0.803				2.44	
GOC2 – Waste reduction capability	0.819				2.58	
GOC3 – Resource optimization	0.786				2.23	
GOC4 – Environmental learning & adaptation	0.773				2.09	
Competitive Advantage (CA)		0.621	0.889	0.853		Porter (1985); Barney (1991)
CA1 – Cost leadership through env. efficiency	0.788				2.27	
CA2 – Differentiation via green positioning	0.804				2.43	
CA3 – Green market reputation	0.793				2.35	
CA4 – Regulatory first-mover advantage	0.775				2.14	
Environmental Risk Mitigation (ERM)		0.618	0.886	0.849		Teece *et al*. (1997); Aragón-Correa and Sharma (2003)
ERM1 – Environmental risk identification	0.785				2.22	
ERM2 – Compliance risk control	0.797				2.37	
ERM3 – Pollution liability reduction	0.783				2.19	
ERM4 – Regulatory penalty avoidance	0.769				2.04	
ERM5 – Supply chain environmental risk mgmt	0.791				2.28	
Environmental Dynamism (ED)		0.611	0.882	0.844		Aragón-Correa and Sharma (2003)
ED1 – Market environmental volatility	0.781				2.18	
ED2 – Technological change intensity	0.796				2.31	
ED3 – Regulatory change frequency	0.774				2.09	
ED4 – Stakeholder env. pressure shifts	0.763				1.97	

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

Discriminant validity was assessed via HTMT ratios **(Table 3)**. All HTMT values ranged from 0.403 to 0.731, comfortably below the conservative 0.85 threshold (Henseler *et al*., 2015). The Fornell-Larcker criterion was also satisfied: each construct's square root AVE exceeded its inter-construct correlations. These results collectively confirm the measurement model's psychometric integrity.

Table 3. Discriminant Validity: HTMT Ratios

Construct	EMS	GOC	CA	ERM
EMS	—			
GOC	0.723	—		
CA	0.661	0.718	—	

ERM	0.647	0.703	0.731	—
ED	0.421	0.469	0.403	0.438

Note. Values below 0.85 confirm discriminant validity (Henseler *et al.*, 2015). EMS = Environmental Management Systems; GOC = Green Operational Capabilities; CA = Competitive Advantage; ERM = Environmental Risk Mitigation; ED = Environmental Dynamism.

Structural model results and hypothesis testing

Tables 4 and 5 report structural model results. R^2 values ranged from 0.231 (GOC) to 0.534 (ERM), demonstrating moderate-to-substantial explanatory power across endogenous constructs (Hair *et al.*, 2019). Notably, the model explains 53.4% of variance in ERM—a substantial figure for a construct that has rarely been modeled as an explicit outcome in EMS research. Q^2 values exceeded zero for all endogenous constructs (GOC: 0.141; CA: 0.258; ERM: 0.337), confirming predictive relevance. Average f^2 values ranged from 0.131 to 0.224, indicating small-to-medium effect sizes (Cohen, 1988).

Table 4. Structural Model: Path Coefficients and Hypothesis Testing

H	Relationship	β	S.E.	t-stat	p	Decision
H1	EMS → GOC	0.481	0.057	8.439	< .001	Supported
H2	EMS → CA	0.317	0.064	4.953	< .001	Supported
H3	EMS → ERM	0.271	0.066	4.106	< .001	Supported
H4	GOC → CA	0.451	0.059	7.644	< .001	Supported
H5	GOC → ERM	0.364	0.061	5.967	< .001	Supported
H6	CA → ERM	0.489	0.055	8.891	< .001	Supported
H7	EMS → GOC → CA (mediation)	0.217	0.036	6.028	< .001	Supported
H8	EMS → GOC → ERM (mediation)	0.175	0.033	5.303	< .001	Supported
H9	GOC → CA → ERM (mediation)	0.221	0.038	5.816	< .001	Supported
H10	EMS→GOC→CA→ERM (serial)	0.106	0.028	3.786	< .001	Supported
H11	ED × EMS → GOC	0.157	0.045	3.489	< .001	Supported

Note. β = standardized path coefficient; S.E. = bootstrapped standard error (5,000 subsamples); t-statistics and p-values from two-tailed bootstrapping. 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.)
Green Operational Capabilities (GOC)	0.231	0.228	0.141	0.131
Competitive Advantage (CA)	0.412	0.406	0.258	0.187
Environmental Risk Mitigation (ERM)	0.534	0.526	0.337	0.224

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

H1 (EMS → GOC: β = 0.481, t = 8.439, p < .001) emerged as the strongest first-order structural path, confirming that formal EMS infrastructure systematically builds green operational capabilities. This finding aligns with Sharma and Vredenburg (1998), who found that proactive environmental strategies generate unique organizational capabilities, and with the NRBV argument that EMS cultivates pollution-prevention and clean-technology capabilities (Hart, 1995). H2 (EMS → CA: β = 0.317, t = 4.953, p < .001) and H3 (EMS → ERM: β = 0.271, t = 4.106, p < .001) were both supported, confirming the dual-outcome direct effect of EMS. The smaller magnitude of these direct effects relative to H1 is theoretically coherent: EMS's primary value proposition lies in capability building, so its direct advantage and risk-reduction effects capture only the portion of EMS value not mediated through GOC.

H4 (GOC → CA: β = 0.451, t = 7.644, p < .001) was supported, confirming that green operational capabilities translate into competitive advantage through cost reduction, differentiation, and market-positioning mechanisms consistent with Porter (1985) and Barney (1991). H5 (GOC → ERM: β = 0.364, t = 5.967, p < .001) was likewise supported, showing that capability-driven operational improvements directly reduce environmental risk exposure. H6 (CA → ERM: β = 0.489, t = 8.891, p < .001) produced the largest path coefficient in the model's second tier, indicating that competitive advantage is the strongest proximal driver of ERM—reinforcing the argument that the financial and reputational gains from environmental competitive positioning generate both the organizational will and the resources to invest in proactive risk governance.

Turning to mediation, H7 (EMS → GOC → CA: β = 0.217, 95% CI [0.148, 0.289]) and H8 (EMS → GOC → ERM: β = 0.175, 95% CI [0.111, 0.243]) were both supported, with confidence intervals excluding zero, confirming partial complementary mediation. H9 (GOC → CA → ERM: β = 0.221, 95% CI [0.149, 0.295]) was also supported, confirming that competitive advantage partially mediates the GOC–ERM relationship. The serial mediation hypothesis H10 (EMS → GOC → CA → ERM: β = 0.106, 95% CI [0.058, 0.157]) was likewise confirmed: although the serial indirect effect is smaller than the individual indirect effects, its statistical significance carries theoretical weight, showing that the full capability-and-advantage-building chain contributes incrementally to ERM beyond the shorter indirect paths.

H11 (ED × EMS → GOC: β = 0.157, t = 3.489, p < .001) was supported. The interaction pattern shows that the positive slope of EMS on GOC steepens as environmental dynamism rises from low to high, confirming that dynamism amplifies the capability-building returns of EMS. This finding extends Aragón-Correa and Sharma's (2003) contingent NRBV framework by providing direct empirical evidence that EMS investment is disproportionately valuable in more volatile and uncertain environmental contexts—a practically important implication for firms operating in Vietnam's rapidly evolving regulatory and competitive landscape.

Theoretical and practical discussion

These findings advance theory on four fronts. First, by empirically confirming the dual-outcome model (EMS → CA and EMS → ERM simultaneously), this study closes a notable gap in the EMS literature: prior work examining competitive or risk outcomes in isolation has offered only an incomplete account of EMS's strategic value. The dual-outcome framework shows that EMS creates value through both value creation (advantage) and value protection (risk reduction) pathways—a distinction with important implications for investment justification and strategic positioning.

Second, confirming GOC as a mediating mechanism advances the NRBV by empirically operationalizing the capability-building process through which EMS commitment produces downstream strategic outcomes. Hart (1995) theorized this pathway but could not validate it empirically; this study supplies that validation. The finding that GOC mediates EMS → CA and EMS → ERM only partially—rather than fully—points to complementary mediation: EMS generates both direct strategic effects and capability-mediated effects, with the latter representing the larger share.

Third, the serial mediation result (EMS → GOC → CA → ERM) shows that the three-stage value chain is empirically viable: capability building, competitive advantage, and risk mitigation form an ordered progression rather than merely parallel outcomes of EMS. This suggests that the competitive-advantage stage is not simply an end-state but an enabling condition for more advanced risk governance—a theoretically important insight that positions CA as an intermediate variable in environmental sustainability value creation. Fourth, the ED moderation result (H11) contributes to the DCT literature by providing boundary-condition evidence that the capability-building benefits of EMS depend on environmental uncertainty, consistent with Teece *et al.*'s (1997) argument that dynamic capabilities are most valuable in rapidly changing environments.

For managers, the study offers three actionable recommendations. First, EMS investment should be framed and evaluated as a dual-outcome strategic investment, with both competitive advantage and risk mitigation included in EMS ROI calculations. Second, because GOC is the primary mediating mechanism, EMS implementation should prioritize operational capability development: green process redesign, waste-reduction programs, and environmental learning systems warrant dedicated resources and management attention beyond mere compliance requirements. Third, for firms operating in high-dynamism environments—facing rapid regulatory change, technological disruption, or volatile stakeholder pressure—EMS investment yields disproportionately higher GOC returns, strengthening the business case for advanced EMS under these conditions.

CONCLUSION

This study developed and empirically tested a comprehensive dual-outcome model linking Environmental Management Systems to Competitive Advantage and Environmental Risk Mitigation through Green Operational Capabilities, with Environmental Dynamism as a moderator. Using PLS-SEM on survey data from 312 Vietnamese manufacturing and service firms, all eleven hypotheses were supported. EMS directly drives GOC (β = 0.481), CA (β = 0.317), and ERM (β = 0.271); GOC strengthens both CA (β = 0.451) and ERM (β = 0.364); and CA advances ERM (β = 0.489). Serial mediation is confirmed (β = 0.106), and environmental dynamism amplifies the EMS–GOC relationship (β = 0.157). The model explains 53.4% of the variance in ERM and 41.2% of the variance in CA, demonstrating substantial predictive power.

The study makes three primary theoretical contributions: (1) it establishes the first empirically validated dual-outcome EMS framework integrating competitive and risk perspectives; (2) it identifies GOC as the capability-building mechanism bridging EMS formulation and strategic outcomes; and (3) it provides evidence of full serial mediation (EMS → GOC → CA → ERM), showing that competitive advantage is not merely a co-outcome with ERM but an enabling condition for it. For policymakers in Vietnam and comparable emerging economies, these findings support regulatory and incentive frameworks that reward genuine depth of EMS implementation—not merely certification status—since implementation quality is the primary determinant of both competitive and risk-management outcomes.

Several limitations point to directions for future research. The cross-sectional design precludes longitudinal tracking of the EMS–GOC–CA–ERM development sequence; panel studies would strengthen causal claims. The single-country sample limits generalizability; future research should extend the model to other ASEAN emerging economies and examine whether country-level regulatory stringency moderates key relationships. Digital environmental management—AI-enabled emissions monitoring, IoT-based process optimization, and digital compliance management—also represents a potentially powerful amplifier or complementary mediator that future studies should incorporate. Finally, multi-group analyses comparing ISO 14001-certified and non-certified firms would help clarify whether the confirmed relationships hold uniformly across levels of EMS maturity.

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