

Unfolding green innovation through green human resource management: The roles of green creativity and green transformational leadership

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Received 12 February 2026; revised 21 June 2026; accepted 11 July 2026

Abstract:

In the context of increasing environmental pressures and the growing importance of sustainable competitiveness, organisations are seeking strategic mechanisms to enhance green innovation (GI). This study investigates the relationships among green human resource management (GHRM), green creativity (GC), GI, and green transformational leadership (GTL). Drawing on the natural-resource-based view (NRBV) and social cognitive theory (SCT), the research develops and tests an integrated model explaining how organisational and psychological factors jointly foster GI outcomes. Data were collected from 339 managers and employees working in Vietnamese enterprises and analysed using partial least squares structural equation modelling (PLS-SEM) with SmartPLS. The findings indicate that GHRM significantly enhances both GC and GI. GC partially mediates the relationship between GHRM and GI, highlighting its role as an important internal mechanism translating HR practices into innovation outcomes. Finally, the results of the moderation analysis indicate that GTL significantly moderates the relationship between GHRM and GC. In addition, GTL positively moderates the relationship between GHRM and GI, strengthening the effectiveness of green HR practices under transformational leadership conditions. By integrating NRBV and SCT, this study extends the literature on green management by clarifying the multilevel mechanisms through which GHRM contributes to GI. The results offer important implications, suggesting that firms should combine green-oriented HR systems with transformational leadership behaviours to stimulate creativity and sustain competitive advantage.

Keywords: green creativity, green human resource management, green innovation, green transformational leadership.

Classification numbers: 1.4, 2.2, 7

1. Introduction

Environmental concerns and sustainable practices have gained growing scholarly and managerial attention in recent decades [1]. Resource scarcity, environmentally conscious consumers, societal pressures, and stricter regulations are driving firms toward a more balanced approach to economic growth and environmental sustainability, prompting a shift from traditional management practices to environmentally friendly strategies to maintain competitiveness and long-term performance [2].

Within the sustainability agenda, sustainable development prioritises objectives such as emission reduction, energy efficiency, and material recycling. Achieving these goals increasingly depends on firms' capacity to innovate through environmental practices that support greener operations. In this regard, GI has been recognised as a critical mechanism through which firms

reconcile environmental responsibility with competitive performance [3-5]. By encompassing green product, process, and managerial innovations, GI enables organisations to reduce environmental impacts and enhance energy efficiency [6]. Consequently, GI not only advances environmental protection but also strengthens corporate reputation and long-term organisational value [7]. Crucially, GC underpins the development of GI by generating novel and useful ideas that translate environmental intentions into sustainable outcomes [7, 8]. Amid the shift toward sustainability-oriented innovation, GHRM is a strategic approach for integrating environmental sustainability into organisational culture and practices [9]. GHRM comprises a bundle of HR practices through which organisations deliberately tackle environmental and ecological challenges [10, 11].

However, formal GHRM alone is insufficient to fully stimulate GC, highlighting the crucial role of leadership

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support [12, 13]. A recent systematic review on GI in the Vietnamese context emphasises the insufficient examination of mediating and moderating mechanisms in GI research, as most studies focus on simple linear relationships [14]. In the rapidly changing business environment, effective leadership is central to shaping organisations' strategic direction and navigating the present challenges of ecological governance [15, 16]. Effective leadership styles have been shown to positively shape individual and organisational learning outcomes, with transformational leadership promoting deep learning and core skill development [17]. Similarly, C.A. Ramus (2001) [18] highlights that supervisors' environmentally focused support is more effective in encouraging employee eco-initiatives than general managerial support. Therefore, by complementing HR systems, GTL helps articulate a clear environmental vision and motivates employees to achieve ecological goals [8], thereby strengthening GHRM effectiveness by fostering psychological support and shared environmental norms [19]. Together, GHRM and GTL create an enabling context in which GC and GI can thrive.

Research from Pakistan suggests that GTL's moderating role in the GHRM-GI relationship may be uneven, manifesting only through green ability rather than across all GHRM dimensions [20], indicating a nuanced and context-dependent interaction that warrants further investigation. Moreover, evidence on GTL's direct moderating role in the GHRM-GC relationship also remains limited, with prior research emphasising largely indirect mechanisms [21, 22]. Yet, both theoretically and empirically, the integrated mechanism linking GHRM, GC, and GI under the moderating influence of GTL remains insufficiently specified and tested. To address these gaps, this paper aims to answer the following research question (RQ):

RQ1: How does GHRM influence GC and GI in Vietnamese enterprises?

RQ2: Does GC mediate the relationship between GHRM and GI?

RQ3: How does GTL moderate the direct impacts of GHRM on both GC and GI?

Addressing these questions is particularly important in developing economies, where rapid economic growth often coexists with persistent environmental challenges and the limited diffusion of green initiatives [23, 24]. Vietnam offers a compelling empirical setting: as one of ASEAN's fastest-growing industrial economies, its GDP also expanded significantly. Despite strong government commitments, including a net-zero emissions pledge by 2050 at COP26 and ambitious renewable energy targets, environmental outcomes remain weak [25].

This underscores the need for Vietnamese firms to adopt proactive, internally driven sustainability strategies underpinned by strong leadership commitment and direction to foster GC and translate it into GI, thereby aligning economic growth with environmental responsibility.

Therefore, drawing on the NRBV and SCT, this study advances the sustainable HRM literature by developing an integrated framework that explains how and under what conditions GHRM translates into GI through GC and leadership influences [26-28]. Although SCT focuses on individual-level processes, this study leverages insights from Multilevel Theory to explain how individual cognitions and behaviours, through social interaction and coordination, emerge as collective capabilities and scale up to organisational outcomes [29]. Accordingly, SCT serves as the micro-foundation through which NRBV-based resources are translated into GC and firm-level GI outcomes [30], with the interaction between GHRM and GTL fostering a supportive organisational climate, thereby offering practical insights into how Vietnamese firms can leverage internal capabilities to reconcile economic and environmental objectives.

2. Literature review and hypotheses development

2.1. Green human resource management and green innovation

The NRBV extends the traditional RBV by integrating the natural environment into the analysis of firm resources and capabilities, emphasising environmentally oriented strategic capabilities as sources of competitive advantage [26, 31]. This competitive advantage is derived from three interrelated strategies: pollution prevention, product stewardship, and sustainable development, which integrate environmental protection with profitability [26, 32], and closely map onto the dimensions of GI [15, 33].

GI is commonly defined as product and process innovations that aim to reduce negative environmental impacts [34, 35]. However, this study conceptualises GI as comprising green product, process, and managerial innovation [36], with green managerial innovation providing the managerial foundation that supports and enables other GI through the effective adoption and operation of environmental management systems and tools [37].

Consistent with the NRBV, developing such capabilities and achieving GI require continuous improvement, stakeholder integration, and a shared vision [26, 33]. These are embedded in firms' human and leadership systems, relying on employees' skills, learning, and commitment, alongside managerial support for articulating and sustaining environmental goals

[11, 16, 30]. In this regard, GHRM functions as a strategic capability that mobilises firms' human capital to stimulate GI and strengthen competitive advantage [38], with additional evidence from Vietnam [39].

GHRM encompasses HR practices, including green recruitment and selection (GRS), green training and development (GT), green performance management (GP), green pay and rewards (GPR), and green employee involvement (GEI) [40, 41], through which organisations intentionally address environmental and ecological challenges [10, 11]. Through these practices, GHRM affects GI by fostering employees' environmental knowledge and skills through GT, stimulating their motivation to participate in environmental initiatives, and building an innovation-supportive climate that values employee involvement and idea sharing [42-44]. Innovation is more likely when organisations cultivate a work environment that encourages employees to generate new ideas, embrace change, and proactively explore opportunities [45].

Firms increasingly leverage HRM systems to meet environmental responsibilities and enhance GI [46]. They benefit from attracting and retaining employees who demonstrate strong environmental commitment and active engagement in green initiatives [10]. Such employees are more likely to engage in eco-friendly behaviours and create novel and useful ideas, which fosters GI, particularly in developing countries [42, 47]. Moreover, GEI enables employees to meaningfully apply their environmental knowledge and skills [48], while GP and GPR connect employee behaviours with organisational environmental goals, ultimately stimulating GI [39, 49]. Notably, recent evidence shows that GPR influences GI more strongly than other GHRM practices [50]. In Vietnam, research grounded in NRBV similarly confirms that GHRM significantly enhances GI among small and medium-sized enterprises in Ho Chi Minh City [51]. Taken together, these findings underscore GHRM as a strategic mechanism that strengthens firms' GI performance:

H1: GHRM positively affects GI.

2.2. Green human resource management and green creativity

Creativity refers to the generation of novel and useful ideas by an individual or a small team working together [52]. In organisational settings, creativity focuses on idea generation, whereas innovation involves the implementation of these ideas [53]. Extending this to the environmental domain, GC denotes the development of novel and useful ideas related to green products, services, processes, or practices, forming the ideational foundation for GI [8, 54]. Strategically, GC constitutes

a critical component of organisational capability, as the development of new products serves as a growth engine for revenues, sales, and competitive advantage [55], as further reinforced by NRBV-based evidence [56].

However, the emergence of GC is not automatic. Creativity requires rethinking existing organisational policies, processes, and practices, and creative ideas are most likely to arise when employees receive strong co-worker feedback and support, as well as organisational encouragement [57]. Thus, in today's environmentally challenged business context, promoting GC has become increasingly essential for HRM [22].

GRS attracts and preferentially selects individuals with strong environmental awareness and alignment with the firm's green values [10, 55]. Such individuals are more likely to actively participate in GC, and their high environmental sensitivity enables organisations to adjust strategies in a timely manner in response to external environmental changes [58]. GT further enhances employees' environmental knowledge, awareness, and problem-recognition abilities, promoting proactive and voluntary participation in environmental activities [22, 59]. Through GEI, firms provide employees with autonomy and participatory platforms in environmental management, facilitating knowledge sharing and encouraging active engagement in GC [9]. Additionally, integrating green objectives and creativity criteria into GP and GPR, alongside constructive feedback, can enhance cognitive capabilities and promote GC by functioning as informational and enabling extrinsic motivators [60, 61].

Hence, we posit that GHRM creates supportive conditions, resources, and incentives that stimulate GC in Vietnam:

H2: GHRM positively affects GC.

2.3. Green human resource management, green creativity and green innovation

Creativity and innovation in the workplace have become increasingly critical to firms' performance and long-term success [53]. Innovation is rooted in creative ideas, as creativity at the individual and team levels initiates the innovation process [52]. Creativity enables firms to identify and exploit opportunities that enhance their innovative capacity [62].

In the green context, organisations strengthen GI outcomes by implementing creative green ideas in procedures, practices, or products [51]. From the NRBV perspective, sustainable competitive advantage arises from transforming conventional processes into environmentally sustainable solutions [26, 30]. Creativity is regarded as a key driver of innovative organisational solutions to environmental challenges, sustainable

products and processes that benefit both current and future generations [34, 62]. Moreover, growing customer demand for environmentally responsible practices intensifies firms' need to translate creative green ideas into sustainable innovations to enhance customer loyalty in the Vietnamese manufacturing context [7]. Ideas generated through GC, once operationalised in organisational processes, increase the likelihood of successful GI and competitive advantage [63].

GC also serves as a behavioural mechanism translating GHRM's cognitive and motivational effects into tangible outcomes, as evidenced by its mediating role between GHRM and sustainable development [9]. In this regard, without such creative engagement, the capacity of GHRM to drive sustainability may remain limited to policy compliance rather than enabling transformative change.

GHRM practices extend beyond operational adjustments by serving as strong psychological cues that influence employees' perceptions, attitudes, and subsequent green creative behaviours. As a result, employees who demonstrate GC are more inclined to generate environmentally friendly product ideas, reconfigure processes, and participate in eco-innovation activities, directly supporting organisational sustainability goals [13]. Evidence from Pakistan further supports this mechanism, showing that GHRM stimulates employees' green behavioural intentions and creativity by emphasising and rewarding pro-environmental behaviour, which leads to GI [64]. Therefore, we propose that:

H3: GC positively affects GI.

H4: GC mediates the relationship between GHRM and GI.

2.4. Green transformational leadership

The NRBV emphasises that long-term environmental strategies grounded in shared sustainability vision enable firms to build rare capabilities for competitiveness, especially in resource-constrained emerging markets [26]. Within this framework, GTL helps employees internalise a long-term sustainable environmental vision [30, 65]. Thus, this study views GTL as an intangible resource that fosters environmentally oriented capabilities and supports the attainment of sustained competitive advantage [15, 16, 33].

GTL describes leadership behaviours that inspire followers to pursue environmental objectives beyond expected performance standards [8]. Drawing on transformational leadership theory [66, 67], GTL comprises four dimensions: intellectual stimulation, individualised consideration, idealised influence

(charisma), and inspirational motivation, reframed to advance environmental sustainability goals [19]. These dimensions are manifested through leaders' role modelling, the articulation of an inspiring green vision, the encouragement of critical thinking and innovation in environmental practices, and individualised support that fosters employees' environmental capabilities and value internalisation. Transformational leaders focus on increasing followers' intrinsic motivation, growth, and emotional support [67]. Therefore, they facilitate enduring changes and support followers' learning and development.

Accordingly, prior studies have predominantly examined GTL as an independent variable directly influencing GC [68, 69] and GI [11, 15]. Other streams of research highlight the moderating role of various leadership styles in the GHRM-GC relationship, including ethical leadership [70], spiritual leadership [1], and environmentally specific servant leadership [71]. However, despite emerging evidence that GTL moderates the indirect effects of GHRM on GC, the direct moderating role of GTL in the GHRM-GC relationship remains underexplored [21, 22].

Thus, to address this gap, we integrate SCT [27, 28] as a psychological perspective alongside the NRBV to explain more comprehensively how and why GTL moderates this relationship. In this theoretical framework, this study suggests that GTL serves as a multilevel integrative mechanism, linking the organisation's sustainable strategic orientation (NRBV) with individual-level factors in the SCT framework. This integration is theoretically appropriate because creativity is not a single outcome but a holistic configuration of social and psychological components [69].

Rejecting one-sided determinism, SCT advances a triadic model of reciprocal causation, wherein personal attributes, behavioural processes, and environmental conditions function as interdependent forces that jointly shape outcomes [27, 28]. From this perspective, individuals' learning and performance are influenced by observational learning, social modelling and regulated through self-efficacy and self-regulatory processes, rather than being driven solely by external factors. SCT therefore offers a micro-level explanation, emphasising that GC is shaped not only by formal HRM practices but also by leadership-driven social and psychological processes. To enrich the theoretical model, we also re-examine GTL's moderating role in the GHRM-GI relationship in a different institutional context, extending prior evidence from the Pakistan manufacturing sector to Vietnam across industries [20].

2.5. Interaction between green human resource management and green transformational leadership on green innovation and green creativity

According to SCT, employees do not merely comply with externally imposed standards but internalise behavioural norms through interaction with influential role models [27, 28], making leadership an important social cue in shaping pro-environmental motivation and conduct. Accordingly, when GHRM practices signal environmental expectations, GTL reinforces and legitimises these signals through role-modelling and social learning processes, ultimately strengthening their environmental moral commitment and self-efficacy [19, 72].

Reliance on formal GHRM mechanisms alone often leads to only partial integration of green employee engagement, making leadership role modelling crucial for complementing these practices to strengthen employee engagement across contexts (i.e., UK, Sweden, Germany). Within this perspective, GTL behaviours drive the adoption of environmentally oriented practices that enhance GI [20]. By embodying top management's environmental values, they shape how GHRM is interpreted and enacted. As top management's dedication and proactive stance toward environmental innovation provide the authority, resources, and legitimacy necessary to translate GHRM-driven employee engagement into tangible GI, especially green managerial innovation [73]. Besides, employees are more inclined to engage in environmental initiatives when supervisors adopt an open and participative communication style and managers actively involve employees across organisational levels regarding environmental issues [18, 43].

Through intellectual stimulation, GTL behaviours encourage employees to re-examine conventional processes, explore novel ideas, and generate creative solutions to environmental challenges [8, 74] by trusting their environmental abilities and acknowledging contributions [11]. In addition, by providing individualised consideration, they address followers' unique needs and offer coaching and feedback that promote environmental learning and creativity, and set high performance expectations that encourage followers to approach tasks creatively [21, 68]. Their charisma and inspirational motivation cultivate enthusiasm, articulate shared environmental goals, and raise employees' commitment to sustainability [69]. Consequently, GTL, aligned with GHRM, fosters a supportive psychological climate that enhances employees' engagement, GC, and GI.

This supportive climate is particularly important for creativity. Since a supportive and rewarding environment is essential for fostering motivation toward creative idea generation [75], psychological safety enables

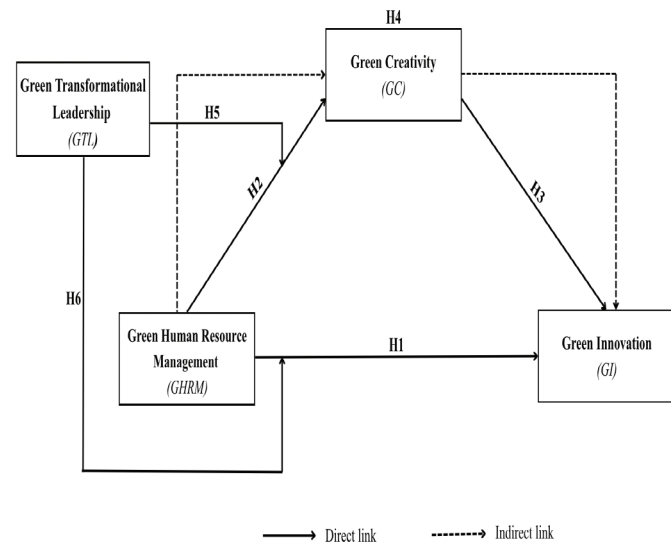
risk-taking [76], and without environmental support, creative potential may remain unexpressed even among capable individuals [77]. Accordingly, supervisory support and facilitator competence are key to creating such climates [13]. Thus, these arguments suggest that GTL does not operate in isolation but interacts synergistically with GHRM to strengthen both GI and GC. Specifically, GTL moderates the GHRM-GC relationship by reinforcing green self-efficacy, intrinsic motivation, and a psychologically supportive environment for creativity, while simultaneously moderating the GHRM-GI relationship by legitimising environmental values, enhancing social learning, and guiding a green strategic vision. Accordingly, based on the integrated theoretical framework of NRBV and SCT, this study proposes the following hypotheses:

H5: GTL positively moderates the relationship between GHRM and GC.

H6: GTL positively moderates the relationship between GHRM and GI.

Based on the above theoretical arguments, the proposed research model is illustrated in Fig. 1.

Fig. 1. Proposed research model.



Source: The author's proposal.

3. Research methodology

3.1. Sampling and data collection

To empirically test the proposed model examining GHRM's effects on GI, with GC as a mediator and GTL as a moderator, this study adopts a quantitative research approach using a structured questionnaire as the primary data collection instrument. Data were

collected from employees and managers working in firms across multiple organisations in Northern Vietnam. A non-probability convenience sampling method was employed to ensure accessibility, flexibility, and efficiency in data collection. Following questionnaire development, an online survey was administered. Questionnaire items were adapted from established scales and translated into Vietnamese using back-translation to ensure equivalence and contextual appropriateness. Prior to the official survey, a pilot test was conducted with a small group to assess the clarity and reliability of the measurement items.

In line with methodological recommendations for PLS-SEM, the adequacy of the sample size was evaluated using the widely accepted “5-10 times rule” [78]. The final valid sample size of N=339 observations was therefore deemed sufficient and appropriate for subsequent PLS-SEM analysis.

3.2. Measurement of the constructs

The questionnaire consisted of observed variables measuring each construct in the proposed research model and employed a five-point Likert scale, ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). Specifically, the GHRM construct was measured using 19 observed variables adapted from G. Tang, et al. (2017) [40]. The GTL and GC constructs comprised six observed variables, respectively, adopted from Y.S. Chen (2013) [8]. Finally, the GI construct was measured using nine observed variables adapted from Y. Zhang, et al. (2020) [36].

3.3. Data analysis

This study employs PLS-SEM to assess the proposed research framework and to empirically test the hypothesised relationships using the collected data [79].

Following data collection, SmartPLS 4 software was used to perform model estimation. The analysis process involved a two-stage evaluation procedure, first assessing the measurement model and then the structural model. Measurement model reliability was evaluated using Cronbach’s alpha and composite reliability (CR) indicators, while construct validity was assessed through tests of convergent and discriminant validity.

The structural model was analysed to examine the hypothesised relationships. A bootstrapping procedure with 339 resamples was applied to estimate the statistical significance of the path coefficients, enabling the evaluation of hypothesis support and the strength of relationships among the latent constructs.

4. Results

4.1. Measurement model

Table 1. Results of factor loadings, reliability analysis and convergent validity.

Construct	Item	Factor loading	Cronbach's alpha	Composite reliability (CR)	AVE (Construct level)	VIF
GHRM	GHRM1	0.714	0.941	0.947	0.529	2.789
	GHRM2	0.68				2.755
	GHRM3	0.72				2.6
	GHRM4	0.674				2.944
	GHRM5	0.747				3.589
	GHRM6	0.73				3.534
	GHRM7	0.756				3.352
	GHRM8	0.671				2.453
	GHRM9	0.733				2.985
	GHRM10	0.702				2.652
	GHRM14	0.804				3.347
	GHRM15	0.779				3.32
	GHRM16	0.715				2.363
	GHRM17	0.761				3.128
	GHRM18	0.72				2.518
	GHRM19	0.714				2.635
GI	GI1	0.824	0.924	0.938	0.654	2.974
	GI2	0.874				3.338
	GI3	0.806				2.809
	GI4	0.823				3.125
	GI5	0.745				2.33
	GI6	0.714				2.078
	GI7	0.84				3.354
	GI8	0.832				2.821
	GI9	0.824				2.974
GTL	GTL1	0.806	0.912	0.931	0.693	1.961
	GTL2	0.852				2.803
	GTL3	0.855				3.375
	GTL4	0.822				2.794
	GTL5	0.82				2.582
	GTL6	0.839				3.822
GC	GC1	0.802	0.917	0.935	0.708	2.257
	GC2	0.853				3.664
	GC3	0.83				2.526
	GC4	0.763				1.937
	GC5	0.907				4.135
	GC6	0.884				4.12

*: GHRM: green human resource management, GC: green creativity, GI: green innovation, GTL: green transformational leadership.

The measurement model was evaluated by examining the internal consistency, reliability, and convergent validity of the latent constructs, including GHRM, GC, GI, and GTL. Internal consistency reliability was assessed using Cronbach's alpha and CR, while convergent validity was evaluated based on the average variance extracted (AVE).

The results reported in Table 1 correspond to the second estimation of the measurement model. During the initial assessment, GHRM11, GHRM12, and GHRM13 exhibited outer loadings below the acceptable threshold of 0.60 and were therefore removed. The model was subsequently re-estimated using the remaining 16 GHRM indicators. As shown in Table 1, all constructs demonstrate strong internal consistency reliability. Specifically, Cronbach's alpha values range from 0.912 to 0.941, exceeding the recommended threshold of 0.70 [79]. Similarly, CR values range from 0.931 to 0.947 and are well above the minimum acceptable level of 0.70, indicating a high degree of reliability across all constructs [80].

With regard to convergent validity, all AVE values exceed the recommended threshold of 0.50. Specifically, the AVE values are 0.529 for GHRM, 0.654 for GI, 0.693 for GTL and 0.708 for GC, indicating that each construct explains more than half of the variance of its respective indicators. In addition, the retained indicator loadings range from 0.671 to 0.907, remaining above the minimum acceptable threshold. Taken together, these results confirm satisfactory convergent validity and support the retention of all indicators in the re-estimated measurement model.

To examine potential multicollinearity among the measurement indicators, the outer variance inflation factor (VIF) values were assessed. According to established guidelines, VIF values below 5 indicate the absence of serious multicollinearity issues [78]. As presented in Table 1, all outer VIF values range from 1.937 to 4.135, remaining below the recommended threshold. Although several indicators exhibit relatively higher VIF values (GC5=4.135; GC6=4.120; GTL6=3.822), these values are still within acceptable limits. Therefore, multicollinearity among the indicators is not a concern, and the measurement model is statistically appropriate for further analysis.

4.2. Structural model

Table 2. Collinearity assessment results.

	GC	GI
GC		1.216
GHRM	1.571	1.715
GI		
GTL	1.63	1.719

*: GHRM: green human resource management, GC: green creativity, GI: green innovation, GTL: green transformational leadership.

Prior to testing the structural relationships, collinearity among the predictor constructs was examined using inner VIF values (Table 2). All inner VIF values range from 1.216 to 1.719, which is well below the recommended threshold of 5 [78]. These results indicate that multicollinearity is not a concern in the structural model, ensuring that the estimated path coefficients are not biased by collinearity issues.

Table 3. Coefficient of determination (R^2) and adjusted R^2 values.

	R^2	R^2 Adjusted
GC	0.178	0.170
GI	0.411	0.404

*: GC: green creativity, GI: green innovation.

The explanatory power of the model was evaluated using the coefficient of determination (R^2) for the endogenous constructs (Table 3). The result for GC ($R^2=0.178$; adjusted $R^2=0.170$) indicates that 17.8% of the variance in GC is explained by its antecedents. This level of explanatory power can be considered weak to moderate.

In contrast, the result for GI ($R^2=0.411$; adjusted $R^2=0.404$) indicates that the model explains 41.1% of the variance in GI. According to commonly accepted benchmarks, this reflects a moderate level of explanatory power, demonstrating that the proposed model has satisfactory explanatory capability for GI outcomes.

Table 4. Effect size (f^2) values for the structural model.

	GC	GI
GC		0.215
GHRM	0.092	0.059
GTL x GHRM => GI		0.13
GTL x GHRM => GC	0.051	
GTL	0.055	0.094

*: GHRM: green human resource management, GC: green creativity, GI: green innovation, GTL: green transformational leadership.

To further assess the relative impact of each exogenous construct on the endogenous variables, effect size (f^2) values were examined (Table 4). The results indicate that GC has a medium effect on GI ($f^2=0.215$), highlighting the important role of GC in driving GI.

The effects of GHRM on GC ($f^2=0.092$) and GI ($f^2=0.059$) are classified as small, suggesting that although GHRM contributes to both outcomes, its independent influence remains relatively modest. Similarly, the interaction effect of GTL and GHRM on GC has a small effect size ($f^2=0.051$), while the interaction effect on GI is stronger but remains below the conventional threshold for a medium effect ($f^2=0.130$). In addition, GTL exhibits small effect sizes on both GC ($f^2=0.055$) and GI ($f^2=0.094$).

Table 5. Heterotrait-Monotrait (HTMT) ratio of correlations.

	GC	GHRM	GI	GTL
GC				
GHRM	0.35			
GI	0.582	0.335		
GTL	0.319	0.556	0.37	

*: GHRM: green human resource management, GC: green creativity, GI: green innovation, GTL: green transformational leadership.

Although discriminant validity is primarily assessed within the measurement model, the HTMT ratio was further examined to ensure that the structural relationships among constructs are not confounded by conceptual overlap. As shown in Table 5, all HTMT values among the core constructs (GHRM, GC, GI, and GTL) are well below the conservative threshold of 0.85, with the highest value being 0.582 between GC and GI. These results confirm that discriminant validity is adequately established, supporting the robustness of the structural model estimates.

4.3. Results

Table 6. Path coefficients and hypothesis testing results.

Hypothesis	Effects	β	t-value	p-value
H1	GHRM => GI	0.244	3.266	0.001
H2	GHRM => GC	0.344	5.083	< 0.001
H3	GC => GI	0.392	6.012	< 0.001
H4	GHRM => GC => GI	0.135	3.578	< 0.001
H5	GTL x GHRM => GC	0.146	2.258	0.024
H6	GTL x GHRM => GI	0.201	4.111	< 0.001

*: GHRM: green human resource management, GC: green creativity, GI: green innovation, GTL: green transformational leadership.

The results of the structural model analysis provide support for the proposed direct relationships among the core constructs. Specifically, H1, which examines the direct effect of GHRM on GI, is supported. The path coefficient from GHRM to GI is positive and statistically significant ($\beta=0.244$, $t=3.266$, $p=0.001$), indicating that the adoption of GHRM contributes positively to firms' GI outcomes. Regarding H2, the findings confirm that GHRM has a positive and significant effect on GC ($\beta=0.344$, $t=5.083$, $p<0.001$), providing strong empirical evidence that GHRM enhances employees' GC. The results also support H3, which posits a positive relationship between GC and GI. The path coefficient from GC to GI is positive and highly significant ($\beta=0.392$, $t=6.012$, $p<0.001$), suggesting that higher levels of GC among employees play a critical role in driving GI within organisations.

Furthermore, GC partially mediates the relationship between GHRM and GI. The indirect effect of GHRM on GI through GC is positive and statistically significant

($\beta=0.135$, $t=3.578$, $p<0.001$), thereby supporting H4. As the direct effect of GHRM on GI remains statistically significant, GC is identified as a partial mediator.

Finally, the results of the moderation analysis indicate that GTL significantly moderates the relationship between GHRM and GC. The interaction effect is positive and statistically significant (H5: $\beta=0.146$; $t=2.258$; $p=0.024$), supporting H5. In addition, GTL also significantly moderates the relationship between GHRM and GI. The interaction term exhibits a positive and statistically significant effect (H6: $\beta=0.201$; $t=4.111$; $p<0.001$), indicating that the positive impact of GHRM on GI becomes stronger under higher levels of GTL. Therefore, H6 is supported.

5. Discussion

This study examines the relationships among GHRM, GI, and GC, while also investigating the moderating role of GTL. The results confirm significant positive relationships, showing that GHRM strongly influences both GC and GI. Specifically, GHRM affects GC mainly at the micro-psychological level by enhancing employees' environmental awareness, intrinsic capabilities, and problem-identification ability through supportive recruitment, training, and feedback practices that encourage green creative engagement [58, 61]. By contrast, the impact of GHRM on GI is more salient at the macro-strategic level. Grounded in the NRBV, GHRM not only develops human capital but also contributes to sustainable competitive advantage by enabling organisations to transform green ideas into green product, process, and managerial innovations [26, 38, 46]. This indicates that GHRM simultaneously supports both the ideation and implementation stages of innovation through distinct underlying mechanisms.

Moreover, the study reinforces W. Song, et al. (2018) [81] by confirming the positive effect of GC on GI. This finding is theoretically grounded, as GC represents a critical ideation stage that forms the foundation for firms' innovation capability [53]. In addition, GC is confirmed as a partial mediator between GHRM and GI, indicating that GHRM enhances GI by shaping employees' green awareness, attitudes, and creative behaviours, thereby improving ecological efficiency and proactive innovation activities [13]. This mechanism is particularly salient in developing countries, where technological and financial constraints make GI heavily dependent on employee creativity, with GHRM serving as a key enabling foundation [9].

While these relationships are statistically significant, the relatively small effect sizes and modest explanatory power for GC suggest that GHRM represents only one component within a broader system influencing green outcomes. This is consistent with the inherently complex

and multidimensional nature of GC and GI, which are shaped not only by organisational practices but also by individual characteristics, team dynamics, and external pressures such as market demand and environmental regulation [82]. Moreover, in the Vietnamese context, GHRM practices are often implemented in a formal or symbolic manner to meet external expectations, rather than being deeply embedded in daily organisational routines. As a result, their direct impact on GI remains limited. Instead, GHRM tends to exert a more gradual and indirect influence by shaping employees' awareness, attitudes, and behaviours over time, which are then translated into innovation outcomes through GC [83]. Therefore, GHRM should be understood as an enabling mechanism that supports, rather than solely drives, GC and GI, particularly in developing-country contexts, where a multitude of economic and socio-cultural constraints often render the comprehensive adoption of green practices highly challenging and amplify the influence of external factors [6].

Regarding GTL, the findings confirm its positive moderating effect on the GHRM-GI relationship, consistent with F.H. Awan, et al. (2023) [20]. By extending this evidence to the Vietnamese context, the study demonstrates that GTL strengthens the effectiveness of GHRM in promoting GI across emerging economies.

Extending prior research on the indirect role, this study provides empirical evidence of the direct moderating role of GTL in the GHRM-GC relationship [21, 22]. Drawing on SCT, GTL functions as a role-modelling mechanism that enhances employees' self-efficacy and intrinsic motivation through observational learning and self-regulation [27, 28]. By fostering a supportive psychological climate characterised by engagement and psychological safety, GTL facilitates the translation of GHRM into GI and GC outcomes, particularly in developing-country contexts with high power distance and strong leadership influence [69, 78, 84].

5.1. Theoretical contributions

First, this study advances the literature by explicitly distinguishing between the micro-psychological and macro-strategic mechanisms through which GHRM influences green outcomes. While prior research has generally treated GHRM as a homogeneous driver, our findings demonstrate that it simultaneously shapes idea generation (GC) and innovation implementation (GI) through fundamentally different pathways.

Second, the study identifies the underlying mechanisms and boundary conditions through which GHRM generates positive outcomes for GI, particularly through the influence of GC and GTL. GC plays a partial mediating role in the GHRM-GI relationship, especially in developing countries where innovation relies heavily on employees' creativity. The role of

GTL in amplifying the effects of GHRM on both GC and GI is reaffirmed through the integration of NRBV and SCT.

Third, by focusing on a developing-country context, this study provides context-specific insights into how GI is fostered under resource constraints, highlighting the heightened importance of employee creativity as a strategic asset.

5.2. Practical implications

Based on the empirical findings, this study offers several practical implications for organisations.

First, organisations should strengthen GTL to maximise the effectiveness of GHRM in promoting GC and GI. Since the findings indicate that GTL enhances the positive influence of GHRM, firms should place greater emphasis on cultivating leaders who actively communicate environmental values, encourage employees' participation in sustainability initiatives, and support experimentation with environmentally friendly practices. Developing green leadership capabilities can therefore improve the implementation of GHRM and create conditions that foster employees' green behaviours and innovation.

Second, organisations should ensure that GHRM is implemented consistently and aligned with broader sustainability objectives. Rather than treating environmental initiatives as isolated activities, firms should integrate green values into core HR practices, including GP, employee development, and reward systems. Such alignment helps reinforce employees' environmental commitment, enhances GC, and ultimately contributes to stronger GI.

Third, given the significant role of GC in driving GI, organisations should create supportive mechanisms that encourage employees to generate, share, and develop green ideas. Providing opportunities for employees to participate in environmental initiatives, recognising valuable contributions, and facilitating the transformation of creative ideas into practical improvements can strengthen organisational innovation capabilities and increase the likelihood that green ideas produce tangible outcomes.

Finally, organisations should foster a supportive organisational climate that encourages continuous learning, collaboration, and experimentation with environmentally sustainable practices. This implication is particularly relevant for Vietnamese enterprises, where resource constraints may limit large-scale environmental investments. By embedding sustainability into everyday organisational practices and encouraging employees' active involvement, firms can gradually strengthen GC and GI, thereby improving their long-term environmental performance and competitiveness.

5.3. Limitations and future research

Despite its contributions, this study has several limitations that should be acknowledged.

First, the data were collected mainly from organisations in Northern Vietnam, which may limit the generalisability of the findings. Future research should include other regions of Vietnam or conduct cross-regional and cross-cultural comparisons to enhance external validity.

Second, this study employed a cross-sectional, limiting causal inference and the ability to capture the cross-level relationships proposed in the theoretical framework. Although GC is conceptualised at the individual level while GHRM and GI operate at the organisational level, the empirical analysis was simplified to a single-level model due to the complexity of the framework and the study's primary focus on the moderating role of GTL. As suggested by D. Tofghi, et al. (2013) [85], future studies should adopt longitudinal and multilevel approaches, such as multilevel structural equation modelling, to better examine these cross-level mechanisms.

Third, GC is a complex construct that may be influenced by various individual, organisational, and contextual factors beyond those included in this model. Future research could incorporate additional antecedents, such as organisational culture, psychological empowerment, environmental knowledge, green climate, or leadership styles, to provide a more comprehensive understanding of the drivers of GC and GI.

Fourth, the use of self-reported data from a single source may introduce common method bias despite the procedural remedies applied. Future studies are encouraged to collect data from multiple sources or apply temporal separation techniques to reduce this risk.

Finally, the use of convenience sampling may reduce sample representativeness and introduce sampling bias. Future research should employ probability sampling techniques to improve the generalisability of the findings.

CRedit author statement

Hoang Linh Anh: Conceptualisation, Methodology, Data Collection, Structuring, Writing Original draft, Writing - Review and Editing; Hoang Thi Hue: Conceptualisation, Supervision, Structuring, Validation, Writing - Reviewing and Editing; Hoang Phuong Huyen: Literature review, Investigation, Writing - Reviewing and Editing; Le Huy Hoang: Writing - Reviewing and Editing, Implications, Conclusions; Nguyen Tuan Phong: Software, Data Curation, Formal Analysis, Visualisation, Writing Original draft, formatting; Pham Ngoc Thai: Software, Data Curation, Formal analysis, Visualisation, Writing Original draft.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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