Cogent Business & Management

ISSN: 2331-1975 (Online) Journal homepage: www.tandfonline.com/journals/oabm20

From green HRM to sustainable business performance: a two-Stage meta-analytic SEM of the mediating role of green innovation

Dedrix Stephenson Bindeeba, Rennie Bakashaba, Eddy Kurobuza Tukamushaba & Susan Atuhaire

To cite this article: Dedrix Stephenson Bindeeba, Rennie Bakashaba, Eddy Kurobuza Tukamushaba & Susan Atuhaire (2025) From green HRM to sustainable business performance: a two-Stage meta-analytic SEM of the mediating role of green innovation, Cogent Business & Management, 12:1, 2536678, DOI: 10.1080/23311975.2025.2536678

To link to this article: https://doi.org/10.1080/23311975.2025.2536678

© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

View supplementary material

Published online: 26 Jul 2025.

Submit your article to this journal

Article views: 872

View related articles

View Crossmark data

Citing articles: 3 View citing articles

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=oabm20

COGENT BUSINESS & MANAGEMENT
2025, VOL. 12, NO. 1, 2536678
https://doi.org/10.1080/23311975.2025.2536678

HUMAN RESOURCE MANAGEMENT | REVIEW ARTICLE

OPEN ACCESS Check for updates

From green HRM to sustainable business performance: a two-Stage meta-analytic SEM of the mediating role of green innovation

Dedrix Stephenson Bindeeba[a], Rennie Bakashaba[a], Eddy Kurobuza Tukamushaba[b] and Susan Atuhaire[c]

[a]Faculty of Business and Management Sciences, Mbarara University of Science and Technology, Mbarara, Uganda; [b]College of Business, University of Doha for Science and Technology, Doha, Qatar; [c]Uganda Martyrs University, Kampala, Uganda

ABSTRACT

This study examines the impact of Green Human Resource Management (GHRM) on Sustainable Business Performance (SBP) through the mediating role of Green Innovation (GI). Using a two stage meta analytic structural equation modeling approach, we synthesize 210 effect sizes from 137 empirical studies across 43 countries and over 167,000 firm observations. Results show that GHRM directly improves economic, environmental, and social performance and strongly predicts GI, which in turn enhances each performance dimension. Mediation analysis confirms that GI partially transmits GHRM's influence across all three SBP pillars. We integrate Ability–Motivation–Opportunity theory, the Theory of Planned Behavior, and the Resource Based View to explain how human resource practices build capabilities that drive sustainable innovation. These findings provide clear guidance for managers and policymakers in designing HR policies that foster green innovation and support sustainability goals.

ARTICLE HISTORY
Received 29 May 2025
Revised 3 July 2025
Accepted 15 July 2025

KEYWORDS
Green human resource management; green innovation; sustainable business performance; meta-analytic structural equation modeling; triple bottom line

SUBJECTS
Environmental Economics; Business, Management and Accounting; Sustainable Development; Environment & the Developing World

1. Introduction

Firms today face a dual imperative: they must maintain competitive advantage and simultaneously answer mounting environmental and social demands. Over the past decade, organizations have turned to two complementary capabilities in pursuit of sustainability. Green Human Resource Management (GHRM) weaves ecological values into core people practice-recruitment, training, performance appraisal, and rewards, to instill pro-environmental mindsets and behaviors throughout the workforce (Carballo-Penela et al., 2023; Munawar et al., 2022; Obeng et al., 2023; Veerasamy et al., 2024). Green Innovation (GI), in turn, encompasses the development and implementation of eco-efficient products, processes, and business models that reduce resource consumption, curb emissions, and uncover new market opportunities (Brunel, 2019; Przychodzen et al., 2020). Although abundant research has established the standalone benefits of GHRM and GI, empirical understanding remains fragmented regarding how these two organizational levers interact to drive Sustainable Business Performance (SBP), defined here as a firm's economic (EP), environmental (EvP), and social (SP) outcomes.

Studies on GI alone often yield mixed results. On one hand, scholars have documented an "innovation penalty," where the upfront cost and complexity of cleaner technologies can temporarily depress operational performance or trigger rebound effects that blunt environmental returns (Lanoie et al., 2011; Wagner, 2010). On the other hand, a "win–win" perspective highlights cases where green research and development not only improves environmental metrics but also enhances competitiveness, drives cost savings, and supports growth (Abdallah et al., 2024; Li et al., 2019). A key differentiator appears to be the presence of robust organizational enablers, chief among them, well-designed GHRM systems. Firms

CONTACT Dedrix Stephenson Bindeeba dedrixbindeeba@gmail.com Faculty of Business and Management Sciences, Mbarara University of Science and Technology, P.O. Box 24985, Kampala, Uganda.
Supplemental data for this article can be accessed online at https://doi.org/10.1080/23311975.2025.2536678.
© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

that systematically recruit for environmental values, invest in eco-training, align appraisals with sustainability goals, and reward green performance are better positioned to convert green ideas into lasting impact (Acquah et al., 2021; Mustafa et al., 2022; Yildiz Çankaya & Sezen, 2019). By contrast, those with sporadic or misaligned HR practices often struggle to implement and scale innovations effectively.

Despite the clear synergy between GHRM and GI, the literature on each remains surprisingly siloed. Carballo-Penela et al. (2023) conducted a meta-analysis of seventy-five studies on GHRM and green supply-chain management, fitting a one-stage structural model that distinguished economic from environmental performance but relegated innovation to a peripheral role and omitted social outcomes entirely. Miah et al. (2024) offered a narrative review of GHRM that mapped themes and publication trends but did not synthesize effect sizes, leaving open questions about the magnitude of HR-driven sustainability gains. Hizarci-Payne et al. (2021) aggregated nearly two hundred correlations to confirm a general eco-innovation–performance link, yet they did not include GHR antecedents and relied on pairwise meta-analysis rather than a multistage approach. Oduro (2024) synthesized ninety-nine SME studies on eco-innovation using bivariate random-effects pooling, again excluding the influence of HR practices. Specialist reviews on micro-level behaviors (Paillé, 2024) and green procurement (Liu et al., 2024) stop short of examining firm-level innovation mechanisms. In none of these syntheses do we find a unified, two-stage meta-analytic structural equation model (MASEM) that can simultaneously account for correlated effect sizes, formally test mediation, and examine economic, environmental, and social performance within a single structural framework.

Primary-level research hints at the promise of linking GHRM and GI, but findings are inconsistent. Awwad Al-Shammari et al. (2022), Kanan et al. (2023), Fang et al. (2022), and Bahmani et al. (2023) report that GI partially or fully mediates the relationship between GHRM and SBP in various industry contexts. Song et al. (2022) find that the strength of this mediation depends on region, firm size, and other contextual factors. Conversely, studies by Zihan and Makhbul (2024) and Aggarwal et al. (2023) reveal robust direct effects of GHRM on economic performance even when GI is omitted. Perez et al. (2023) document a strong link between GHRM and environmental performance, whereas Saputro and Nawangsari (2021) show that misaligned green recruitment or compensation schemes can nullify or even reverse environmental gains. Taken together, these mixed results underscore a critical need for a comprehensive structural analysis that (1) nests GHRM, GI, and disaggregated SBP outcomes; (2) corrects for within-study non-independence; and (3) explores boundary conditions such as industry sector, firm size, and national context.

To address these gaps, we pose the central question: How, and to what extent, do GHRM practices influence economic, environmental, and social performance, both directly and through green innovation? We answer this question using a two-stage meta-analytic structural equation modeling approach (Borenstein et al., 2009; Cheung, 2015; Cheung & Chan, 2004; Hunter & Schmidt, 2004). In Stage 1, we synthesize zero-order correlations across 137 empirical studies into a disattenuated pooled correlation matrix, using multivariate random-effects weights that adjust for shared-sample error. In Stage 2, we fit the full GHRM→GI→EP/EvP/SP mediation model to this matrix, allowing us to estimate direct and indirect effects more accurately than single-stage or pairwise techniques.

Our dataset represents the most comprehensive structural synthesis of GHRM and GI relationships to date. Drawing on 137 eligible studies published through March 2025, we analyze 210 effect sizes based on over 167,000 firm-level observations from forty-three countries and diverse sectors. This scope surpasses previous meta-analytic efforts in both breadth and methodological rigor, enabling a rare assessment of the joint and mediated impacts of HR practices and innovation on sustainable performance.

We ground our hypotheses in three complementary theoretical lenses. At the micro level, the Theory of Planned Behavior (Ajzen, 1991) explains how GHRM shapes employees' attitudes, subjective norms, and perceived behavioral control factors that drive pro-environmental intentions and green idea generation. At the meso level, Ability–Motivation–Opportunity (AMO) theory (Appelbaum et al., 2001) posits that green recruitment, skill-building, incentives, and participatory structures equip and motivate teams to design and test eco-innovations. At the macro level, the Resource-Based View (Barney, 1991) argues that GHRM builds valuable, rare, inimitable green human capital, which in turn underpins GI as a dynamic capability that yields sustainable competitive advantage. Integrated, these perspectives theorize a multi-level chain: GHRM activates individual behaviors (TPB), energizes team capabilities (AMO), and

builds firm resources (RBV) that converge in green innovation, which then drives economic, environmental, and social outcomes.

Our study makes three key contributions. First, it delivers empirical consolidation by synthesizing a diverse corpus of global research. Unlike prior reviews that focus on single dimensions or use simplistic pooling methods, we systematically estimate and compare direct and mediated paths across all three SBP pillars. Second, it advances theoretical integration by uniting TPB, AMO, and RBV in a single structural model, empirically validating how HR systems shape the innovation–performance nexus across micro, meso, and macro levels. Third, it offers methodological innovation through clustered two-stage MASEM, which corrects for non-independence and between-study heterogeneity, yielding more robust mediation tests than conventional meta-analytic techniques.

Beyond academic implications, our findings carry clear practical relevance. By identifying when and how GHRM fosters green innovation, HR leaders and policymakers can design targeted interventions, such as calibrated green training curricula, incentive schemes linked to sustainability targets, and cross-sector innovation hubs, that accelerate firm-level contributions to the Sustainable Development Goals. Demonstrating that GHRM is not a peripheral HR function but a strategic engine of sustainable transformation, this research underscores the critical role of human systems in scaling green innovation.

The remainder of the paper is organized as follows. Section 2 reviews relevant literature and develops our hypotheses. Section 3 details our two-stage MASEM methodology, including study selection, coding procedures, and estimation techniques. Section 4 presents the pooled correlations, structural path estimates, and mediation tests. In Section 5, we discuss theoretical, practical, and policy implications, and Section 6 concludes with limitations and directions for future research. Table 1 presents a concise overview of major meta-analytic and review studies on GHRM, GI, and SBP, highlighting each study's context, theoretical lens, methods, key findings, and unresolved gaps. Table 2 then lays out the core constructs GHRM, GI, EP, EvP, and SP, along with typical business metrics for each and representative articles that have measured those variables.

Table 1. Key meta-analytic and review studies on GHRM, GI, and SBP: Unresolved gaps driving the present study.

Author (Year)	Context and sample	Theory/framework	Variables and method	Principal findings	Unresolved gaps addressed here
Oduro (2024)	SMEs; 99 studies	RBV; Dynamic Capabilities	Four eco-innovation types → SBP; random-effects meta-analysis	All eco-innovation types improve the triple bottom line; organizational innovation strongest	Excludes GHRM; aggregates EP/EvP/SP; no mediation tests; single-stage pooling
Carballo-Penela et al. (2023)	Global firms; 75 studies	AMO and RBV	GHRM → ECP; EvP/GSCM as mediators; one-stage SEM	GHRM directly boosts economic performance and indirectly via EvP & GSCM	Treats multiple effects as independent; omits SP; does not model GI separately; no two-stage MASEM
Hizarci-Payne et al. (2021)	Multi-region firms; 70 studies	Conceptual Eco-Innovation Framework	GI → composite performance; bivariate meta-analysis	Organizational eco-innovation has the strongest significant positive impact on firm performance overall.	No GHRM antecedent; conflates SBP dimensions; relies on pair-wise correlations only
Paillé (2024)	Individual employees; 15 studies	AMO; TPB	GHRM practices → individual EvP; meta-review	Eco-training strongest predictor of pro-environmental behavior	Micro level only; no firm-level EP/EvP/SP; omits GI and mediation paths
Miah et al. (2024)	89 GHRM papers	Sustainability Review	Narrative SLR; bibliometrics	Quantitative GHRM work growing, but heavy on environmental behaviour	No effect-size synthesis; minimal coverage of EP/SP; no GI or mediation
Present Study	137 studies; 210 effect sizes; 43 countries	AMO; TPB; RBV; *Two-Stage MASEM*	GHRM, GI, EP, EvP, SP, composite SBP	GHRM consistently stimulates GI; GI lifts EvP & SP, but smaller EP gains; GHRM directly improves all SBP facets; two-stage model corrects for effect dependence	Introduces GHRM as antecedent, disaggregates SBP, employs clustered two-stage MASEM to test direct & mediated paths and explore heterogeneity

Table 2. Key constructs, performance indicators, and representative studies in the GHRM–GI–SBP framework.

Construct	Business metrics/indicators	Sample articles
GHRM	• Green recruitment and selection • Eco-training hours per employee • Inclusion of environmental criteria in appraisals • Green rewards and incentives	(Ali et al., 2021); Aloqaily (2023); Shafiq et al. (2023), Makumbe (2024); Obeng et al. (2023); Alshuaibi et al. (2024); Carballo-Penela et al. (2023); Perez et al. (2023); Veerasamy et al. (2024)
GI	• Adoption of eco-design practices • Implementation of cleaner production processes • EMS/ISO 14001 certification • Green product/process launches	Chen et al. (2006); García-Machado and Martínez-Ávila (2019); Oduro (2024); Chiou et al. (2011); Brunel (2019); Xie et al. (2019); Li et al. (2023); Ta'Amnha et al. (2024); Ullah et al. (2024); Zihan and Makhbul (2024); Karimi Takalo et al. (2021); Raza (2020)
EP	• Return on assets (ROA) • Sales or revenue growth attributed to green initiatives • Cost savings from resource efficiency	Achmad et al. (2023); Maldonado Guzmám and Pinzón Castro (2023); Yurdakul and Kazan (2020); Lewandowska et al. (2022); Carballo-Penela et al. (2023); Li et al. (2020); Bindeeba et al. (2025)
EvP	• Reduction in CO_2 emissions (tons) • Energy use per unit of output Waste recycled (% of total waste)	Li et al. (2019); Zhang and Walton (2017); Guang-Wen and Siddik (2023); Yurdakul and Kazan (2020); Chughtai et al. (2024)
SP	• Employee health and safety incident rates • Community engagement activities • Customer satisfaction with product safety	Zhu and Jin (2023); Li and Li (2025); Tantayanubutr and Panjakajornsak (2017); Baeshen et al. (2021); Fernando et al. (2019)
SBP (Composite)	• Aggregate sustainability index combining EP, EvP, and SP	Carballo-Penela et al. (2023); Oduro (2024); Imran et al. (2023); Kanan et al. (2023); Zulkiffli et al. (2022)

2. Literature review

2.1. Theoretical review

GHRM is widely viewed as a springboard for organizational sustainability, yet its ultimate effect on SBP depends on whether eco-oriented HR practices are converted into concrete innovations and outcomes. GI the creation and deployment of environmentally friendly products, processes, and routines both bridges and conditions the GHRM–SBP link. To clarify this chain, we knit together three complementary lenses: Ability-Motivation-Opportunity, Theory of Planned Behavior, and the Resource-Based View. Each operates at a different analytical layer, and together they supply a coherent, multi-level account of how and why GHRM drives SBP through GI.

Micro level: TPB holds that behavior flows from intentions, which themselves stem from attitudes, subjective norms, and perceived control (Ajzen, 1991). In a GHRM setting, eco-training, green communication, and transparent appraisal systems cultivate favorable attitudes toward environmental action (Ali et al., 2021; Munawar et al., 2022; Obeng et al., 2023). Embedding sustainability targets in KPIs and leadership rhetoric nurtures pro-environmental norms, signaling that innovation is both expected and valued (Song et al., 2022). Granting employees autonomy, resources, and latitude further boosts perceived control, making staff feel capable of conceiving and executing green ideas. Empirical work confirms that strong intentions generated by robust GHRM schemes raise GI behavior, which in turn feeds environmental and social gains (García-Machado & Martínez-Ávila, 2019; Song et al., 2022).

Meso level: AMO theory argues that performance reflects the joint impact of employees' abilities, motivations, and opportunities (Appelbaum et al., 2001). Green recruitment and targeted training enhance ability to spot and solve eco-problems (Renwick et al., 2013). Incentive system bonuses, recognition, and promotion for sustainability champions stoke motivation (Afzal et al., 2023). Participative forums, cross-functional green teams, and resource support create opportunity for collaborative experimentation (Yang & Li, 2023; Zihan & Makhbul, 2024). When these elements align, teams can design, pilot, and scale eco-innovations. Kanan et al. (2023) show that manufacturers with AMO-aligned GHRM register higher GI, which mediates gains in environmental and social performance. AMO therefore clarifies the group-level "skills, will, and way" through which GHRM fuels systemic GI.

Macro level: RBV posits that sustainable advantage rests on resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). GHRM builds such advantage by nurturing distinctive green human capital employees with specialized eco-knowledge and pro-environmental mind-sets and embedding sustainability in firm culture (Mahmood & Nasir, 2023; Zihan & Makhbul, 2024). These human resources underpin GI as a dynamic capability: the capacity to reconfigure competencies continually to devise eco-products, processes, and business models (Ogiemwonyi et al., 2023; Peng et al., 2024).

Evidence shows GI mediates the link between this HR base and SBP, indicating that firms with strong GHRM convert internal assets into market-relevant eco-innovations that yield differentiated economic, environmental, and social outcomes (García-Machado & Martínez-Ávila, 2019).

Integrated tri-level model. When TPB, AMO, and RBV are woven together, a full pathway emerges: GHRM shapes individual cognitions (TPB), energizes team capabilities (AMO), and builds firm-level resources (RBV) that jointly enable GI. GI then acts as the pivotal mediator through which micro, meso, and macro effects converge to produce SBP. At the micro layer, employees generate green ideas; at the meso layer, teams develop and trial them; at the macro layer, organizational systems scale and embed them into competitive routines. This alignment explains why GI mediates GHRM's impact on environmental and social outcomes more consistently than on economic returns (Mahmood & Nasir, 2023; Kanan et al., 2023), and underscores the need to view HR practices, innovation, and performance as an integrated, multi-level engine of sustainability.

2.2. Hypothesis development

2.2.1. GHRM's influence on green innovation

GHRM directs the skills, motives, and latitude employees need to generate eco-solutions, thereby laying the behavioral groundwork for green innovation. At the micro-level, the Theory of Planned Behavior argues that pro-environmental intentions arise when attitudes, norms, and perceived control are favorable (Ajzen, 1991). Eco-training, green communication, and role-model leadership embedded in GHRM sharpen positive attitudes and social norms, while appraisal systems that score environmental contributions boost perceived control (Setyaningrum & Muafi, 2023; Shafiq et al., 2023).

Moving to the meso-level, AMO theory contends that performance improves when employees have the ability, motivation, and opportunity to act (Appelbaum et al., 2001). Green recruitment and targeted upskilling expand ability; green-bonus schemes and recognition platforms energize motivation; and cross-functional eco-taskforces supply opportunity for collaborative experimentation (Kanan et al., 2023; Zhang et al., 2023). Across hotels in chiana Khan et al. (2025) found that when all three AMO levers were in place, employees demonstrated significantly higher green innovative work behaviour compared to those with none.

At the macro-level, the Resource-Based View emphasizes that unique human capital can yield inimitable capabilities (Barney, 1991). By systematically embedding environmental values in policies and culture, GHRM builds a pool of specialists who can identify and commercialize greener processes faster than rivals (Aloqaily, 2023; Tran, 2023). Emperical evidence from Spanish hospitality chains indicates that cumulative green-skills density significantly improves green ambidexterity, which in turn drives better environmental performance. Similar patterns appear in high-tech firms where green competencies are formally tracked and rewarded (Y. Li et al., 2019). Jointly, these multi-level mechanisms suggest a clear directional link:

H1: GHRM is significantly and positively related to GI.

2.2.2. Green innovation and economic, environmental, social, and SBP (composite) performance

GI functions as a strategic capability through which firms convert internal resources into marketable eco-solutions, a process well explained by the RBV. RBV posits that sustained competitive advantage arises from resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). Firms that invest in green R&D and cultivate technical know-how develop unique competencies enabling cost-effective production, premium pricing, and differentiated market positioning (Bai et al., 2019; Lanoie et al., 2011). These eco-capabilities should thus translate into superior EP. Yet early adopters sometimes face an "innovation penalty" short-term cost increases before efficiency gains materialize (Wagner, 2010).

EvP improvements from GI are more direct and can be illuminated by the TPB and AMO framework at the micro and meso levels. TPB asserts that individuals' attitudes, subjective norms, and perceived behavioral control shape intentions and behaviors (Ajzen, 1991). Eco-training and sustainability communication embedded in GI initiatives foster positive environmental attitudes and strengthen norms around

resource efficiency (Song et al., 2022). Simultaneously, AMO theory emphasizes that performance outcomes stem from employees' abilities, motivations, and opportunities (Appelbaum et al., 2001). Targeted upskilling enhances ability, incentive structures such as "green bonuses" boost motivation, and participatory green teams create opportunities for collaborative problem solving (Renwick et al., 2013; Sobaih et al., 2020). These psychological and capability mechanisms explain why eco-innovations yield measurable reductions in emissions, waste, and resource use (Oduro, 2024; Zihan & Makhbul, 2024). Accordingly, we expect GI to be significantly and positively related to EvP.

SP gains from GI also reflect TPB-driven behavioral change and AMO-enabled capability development, while composite SBP indices capture overall triple-bottom-line outcomes when primary studies do not disaggregate EP, EvP, and SP. GI-driven process innovations that reduce workplace hazards and improve product safety foster positive social outcomes from lower occupational illnesses to enhanced community trust (Fernando et al., 2019; García-Machado & Martínez-Ávila, 2019). These effects emerge as employees translate green intentions into behaviors (TPB) and collaborate within AMO-aligned structures. Composite SBP balances these immediate EvP and SP gains against potentially lagged EP returns, yielding moderate but positive overall effects (Carballo-Penela et al., 2023). Integrating RBV, TPB, and AMO thus provides a multi-level rationale for GI's benefits across performance dimensions.

Consequently, we hypothesize:

H2a: GI is significantly and positively related to EP.

H2b: GI is significantly and positively related to EvP.

H2c: GI is significantly and positively related to SP.

H2d: GI is significantly and positively related to composite SBP when studies do not disaggregate EP, EvP, and SP.

2.2.3. Direct effects of GHRM on EP, EvP, SP, and SBP (composite)

GHRM practices embed sustainability principles into core HR functions, yielding direct economic benefits by enhancing workforce productivity and reducing operational costs. From the perspective of the RBV, GHRM systems build firm-specific, valuable human capital employees equipped with green skills and pro-environmental mindsets, that support process efficiency and innovation-driven cost savings (Barney, 1991; Renwick et al., 2013). TPB further suggests that green recruitment and appraisal practices shape employees' attitudes, intentions, and perceived behavioral control regarding sustainability tasks, thereby promoting proactive cost-reduction behaviors (Ajzen, 1991; Jackson et al., 2011). Empirical support includes Acquah et al. (2021), who report a strong correlation between GHRM and economic performance in manufacturing settings, and Rawashdeh (2018), who find that firms implementing comprehensive green training programs achieve notable improvements in efficiency and profitability. Thus, GHRM is expected to directly enhance EP by aligning employee capabilities and motivations with cost-saving innovation.

Beyond its economic contributions, GHRM is also expected to deliver significant environmental and social performance gains. According to the AMO theory, targeted eco-training (ability), green incentive schemes (motivation), and participatory decision-making structures (opportunity) combine to support continuous environmental improvement by reducing emissions, waste, and resource consumption (Appelbaum et al., 2001; Afzal et al., 2023). For example, Obeng et al. (2023) show that firms adopting green recruitment and appraisal systems achieve meaningful reductions in carbon intensity. Similarly, Imran et al. (2023) report that GHRM practices are positively associated with social responsibility indicators, including employee well-being and community involvement. The TPB framework explains these outcomes through enhanced normative commitment and perceived control, which encourage employees to adopt environmentally and socially responsible behaviors. As such, we expect GHRM to positively influence both EvP and SP.

In cases where primary studies report composite SBP indices, GHRM's diverse effects are expected to converge into broader organizational gains. These composite indices reflect a firm's ability to achieve integrated economic, environmental, and social goals, aligning with the triple bottom line. Emperical evidence supports this integration, with studies such as Carballo-Penela et al. (2023) and Obeng et al.

(2023) finding that high-performance GHRM systems significantly improve overall sustainability outcomes. By embedding environmental values into the organizational culture and aligning performance incentives with sustainability goals, GHRM fosters synergistic capabilities that promote resilience and stakeholder value creation. Accordingly, we propose the following hypotheses:

H3a: GHRM is significantly and positively related to EP.

H3b: GHRM is significantly and positively related to EvP.

H3c: GHRM is significantly and positively related to SP.

H3d: GHRM is significantly and positively related to composite SBP.

2.2.4. The mediating role of green innovation in the GHRM–SBP relationship

The relationship between GHRM and EP is increasingly understood as being mediated by GI. Rooted in the RBV, GHRM builds firm-specific green capabilities such as specialized knowledge, technical skills, and innovation culture that contribute to economic value creation through cost efficiency and innovation-based differentiation (Barney, 1991; Teece, 2007). According to Mahmood and Nasir (2023), eco-innovation significantly mediates the effect of GHRM on SBP. Setyaningrum and Muafi (2023) similarly found that green innovation improves process efficiencies and reduces operational waste, suggesting an indirect pathway between GHRM and SBP via GI. From the TPB lens, green training and recruitment also influence employees' intentions and perceived behavioral control over cost-saving behaviors, reinforcing their contribution to innovation-led financial gains. We thus hypothesize that GI mediates the GHRM–EP relationship.

EvP is another critical outcome that is shaped by the GHRM–GI pathway. The AMO framework explains that GHRM practices such as green skills development (ability), environmental reward systems (motivation), and participative innovation platforms (opportunity) enable employees to initiate and sustain environmental innovations (Appelbaum et al., 2001; Renwick et al., 2013). Ogiemwonyi et al. (2023) found a strong link between GHRM and GI, which subsequently reduced emissions and improved waste management in Malaysian manufacturing firms. Lin et al. (2024) confirm that green organizational practices lead to eco-innovation, which enhances environmental compliance and performance. GI thus serves as a strategic conduit through which GHRM leads to measurable environmental improvements.

SP is also positively influenced through the GHRM–GI link. TPB posits that employees' pro-social attitudes and normative beliefs are shaped by HR practices that promote sustainability values and inclusive engagement (Ajzen, 1991). GHRM fosters a collaborative climate in which employees are empowered to co-create innovations that enhance workplace equity, safety, and well-being (Lin et al., 2024). By embedding social responsibility in green HR systems, firms stimulate innovation that directly benefits both internal stakeholders and the wider community. Empirical support from Carballo-Penela et al. (2023) and Obeng et al. (2023) underscores the social gains achieved when GHRM drives innovation adoption.

When performance is measured as a composite SBP index, GI integrates the economic, environmental, and social impacts of GHRM into broader sustainability outcomes. According to RBV, GI transforms green human capital into synergistic capabilities that support holistic performance across the triple bottom line. Mahmood and Nasir (2023) found that green product, process, and organizational innovation mediated the effect of GHRM on overall SBP among Hospitality firms in Pakistan. Similarly, Carballo-Penela et al. (2023) reported that firms with strong green HR systems and innovation processes achieved higher resilience and stakeholder value. Thus, we propose the following hypotheses:

H4a: Green innovation mediates the relationship between GHRM and EP.

H4b: Green innovation mediates the relationship between GHRM and EvP.

H4c: Green innovation mediates the relationship between GHRM and SP.

H4d: Green innovation mediates the relationship between GHRM and composite SBP.

Figure 1. Conceptual model illustrating hypothesized relationships among Green Human Resource Management, Green Innovation, and dimensions of Sustainable Business Performance (H1–H2d).

3. Methods

The study used a two-stage meta-analytic structural equation model to integrate and synthesize the varied correlation data from our 137 primary studies (Cheung, 2015; Cheung & Chan, 2004). In Stage 1, the study pooled full correlation matrices with multivariate random effects models, preserving within-study dependencies among effect sizes (Cheung & Chan, 2004), correcting for sampling error through inverse variance weighting (Hunter & Schmidt, 2004), and estimating between-study variance τ^2 to capture heterogeneity. This yields a disattenuated pooled correlation matrix, along with its asymptotic covariance, ensuring that non-independent effects and study-level differences are properly accounted for before structural analysis. In Stage 2, the study applied the GHRM→GI→EP/EvP/SP mediation model to this synthesized matrix within a metaSEM framework (Cheung, 2015), allowing simultaneous estimation of direct and indirect paths. Unlike one-stage SEM, which averages effect sizes and may violate independence, or bivariate meta-analysis, which cannot formally test mediation or address multivariate dependencies, TSSEM produces sampling error-adjusted estimates and valid mediation tests tailored to clustered multivariate data.

3.1. Data sources and search procedure

Guided by the PRISMA 2020 framework (Page et al., 2021) and best practices in meta-analytic research within innovation and sustainability domains (Hizarci-Payne et al., 2021; Kuzma et al., 2020; Oduro, 2024). The study undertook a systematic literature search across four major academic databases: Web of Science, Scopus, Business Source Premier (EBSCO), and Google Scholar. These databases were selected for their extensive coverage of peer-reviewed journals in management, human resources, and sustainability science (Oduro, 2024). The study search targeted studies published between January 2000 and May 2025, a period coinciding with the emergence and proliferation of Green Human Resource Management (Paillé, 2024; Renwick et al., 2013).

The search strategy combined three concept clusters Green Human Resource Management, Green Innovation, and Sustainable Business Performance, using Boolean operators and appropriate synonyms. Specific search terms included variations such as "green human resource*" OR "GHRM"; "eco-innovation," "green innovation," OR "environmental innovation"; and "sustainable performance," "economic performance," "environmental performance," OR "social performance." Additional descriptors such as "firm performance," "triple bottom line," and "green HR practices" were iteratively added to ensure conceptual saturation (Oduro, 2024). Searches were restricted to titles, abstracts, and keyword fields to balance breadth with precision.

The initial query yielded 1,340 records. After removing 312 duplicates using Mendeley, a total of 1,028 unique titles and abstracts remained. Two trained coders independently screened these records for

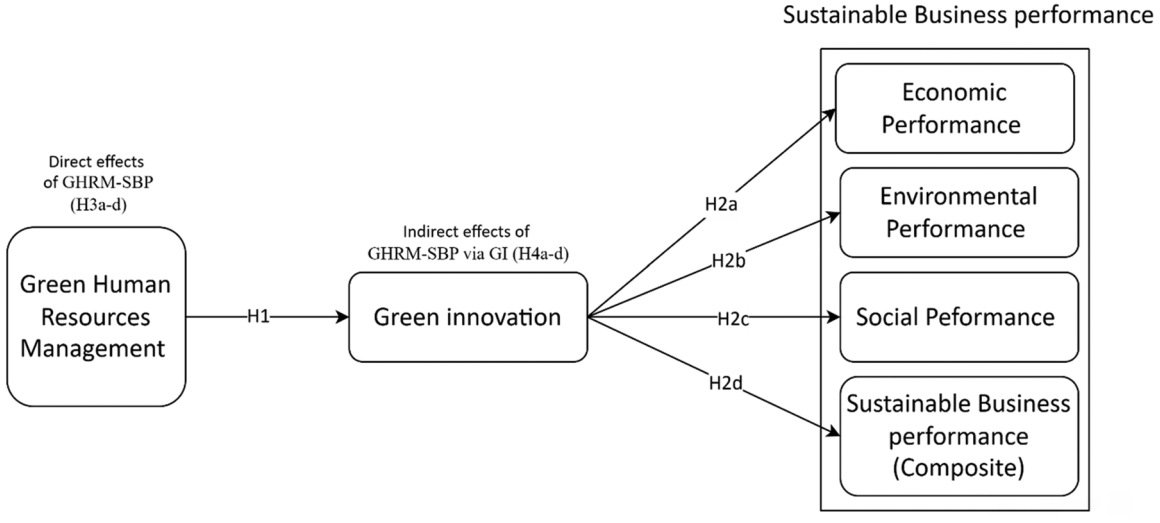


Figure 1. Conceptual model.

relevance based on title, abstract, and methodological content. Discrepancies were minimal (less than 10%) and were resolved in consultation with a senior reviewer. Studies were excluded at this stage if they were theoretical, lacked empirical correlations, or fell outside the scope of HR performance innovation frameworks. This process retained 230 articles for full-text assessment. To reduce publication and indexing bias, we incorporated backward and forward citation tracing on seminal GHRM and GI literature (Carballo-Penela et al., 2023; Hizarci-Payne et al., 2021; Paillé, 2024) and conducted targeted hand-searches in top journals including Journal of Cleaner Production, Business Strategy and the Environment, and Technovation (Abdallah et al., 2024; Carballo-Penela et al., 2023). These steps yielded 9 additional empirical studies, resulting in 239 full-text reports. Ultimately, 137 studies met all inclusion criteria and provided 210 usable zero-order correlations across over 160,000 firm-level observations, forming the analytic basis for the two-stage MASEM (see Figure 2 for PRISMA flow diagram).

3.2. Data coding

To maintain conceptual consistency across studies using varying labels for environmental innovation, such as "green innovation," "eco-innovation," or "environmental innovation," the study adopted a unified definition based on Oduro (2024), treating all as equivalent manifestations of Green Innovation. A detailed codebook was developed drawing on past works of: Perez et al. (2023) and (Obeng et al., 2023) for Green Human Resource Management, Chen et al. (2006) for GI, and Oduro (2024) for Sustainable Business Performance, which includes economic (EP), environmental, and social performance. Three trained coders independently reviewed each study's metadata, including author, year, country, industry, and sample size, and extracted all eligible zero-order correlations across GHRM–GI, GI–SBP, and GHRM–SBP pathways. If multiple correlations or independent samples were present, each effect was retained but linked by a common StudyID to preserve clustering in later analysis.

To ensure coding accuracy, a pilot test was conducted on a random subsample of 30 studies, yielding intraclass correlation coefficients of 0.88 for effect-size extraction and 0.91 for metadata coding, indicating strong inter-coder reliability (Friend et al., 2020; Hunter & Schmidt, 2004). Discrepancies were resolved through consensus, guided by the codebook and Oduro's (2024) innovation taxonomy. Missing reliability data were documented, and all correlations retained.

3.3. Effect-Size metric, transformation, and integration

Consistent with best practices in management meta-analysis (Hunter & Schmidt, 2004; Liu et al., 2024; Rosenbusch et al., 2011), the study adopted the Pearson correlation coefficient (r) as the primary effect-size metric. Pearson's r is widely used in meta-analytic structural equation modeling due to its interpretability, cross-study comparability, and direct compatibility with correlation-based SEM frameworks. Zero-order correlations were extracted directly from primary studies whenever reported. When only p-values were available, we converted them into correlation coefficients using the transformation procedure outlined by Rosenthal and DiMatteo (2001). For studies that reported standardized regression coefficients (β), we applied the widely accepted Peterson and Brown (2005) transformation formula:

$$r \approx 0.98\beta + 0.05\lambda, \qquad \text{where}\,\lambda = \begin{cases} 1, if & \beta > 0 \\ 0, if & \beta < 0 \end{cases}$$

This multi-step approach ensured a harmonized set of effect sizes across studies with varying reporting formats, enabling broader inclusion and maintaining statistical equivalence. To stabilize variances and normalize the sampling distribution of the correlation coefficients, each r was subsequently transformed to Fisher's z using the formula:

$$z = \frac{1}{2}\ln\left(\frac{1+r}{1-r}\right),$$

with the standard error computed as:

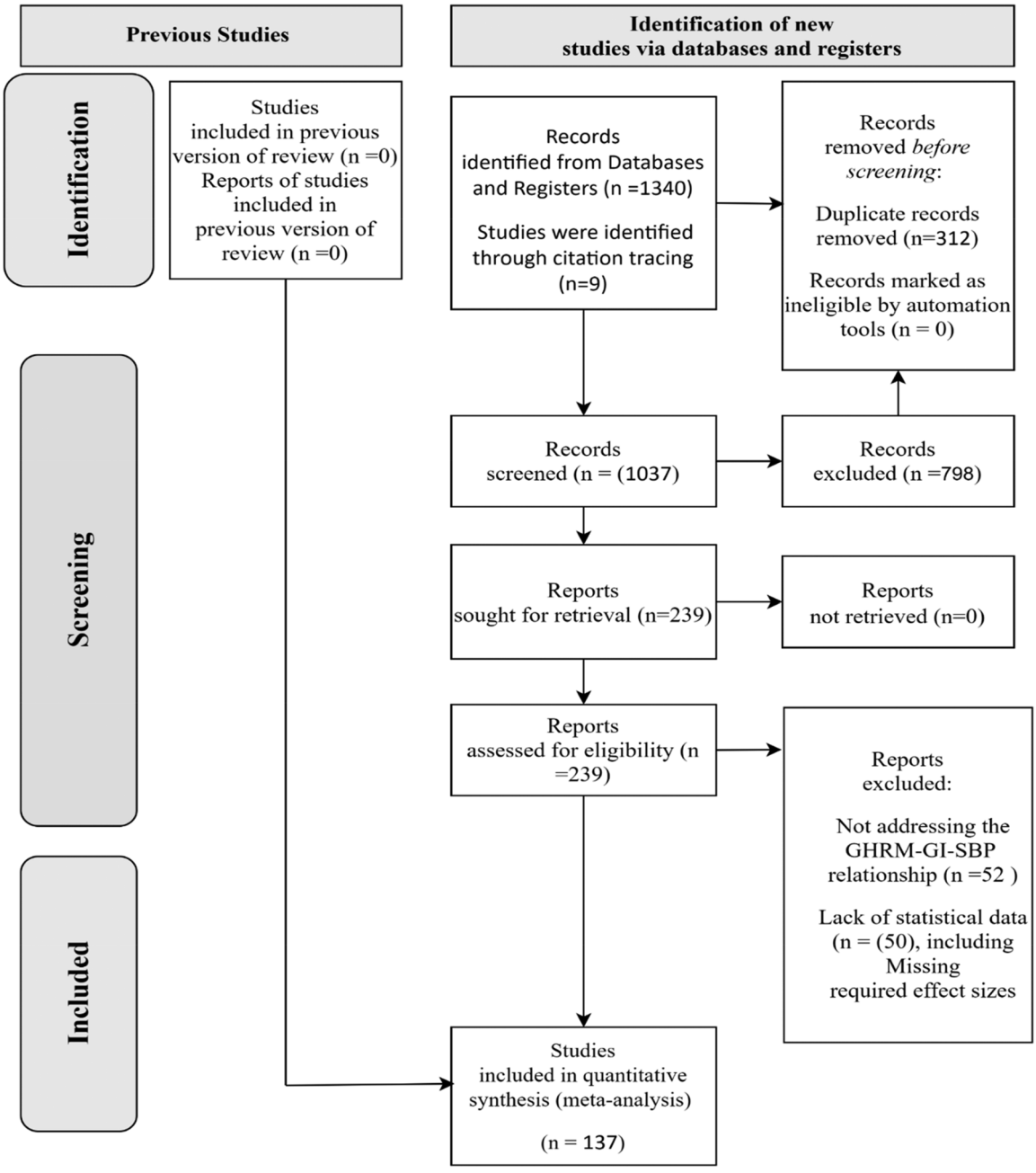


Figure 2. PRISMA 2020 flow diagram showing identification, screening, eligibility, and inclusion of studies.

$$SE_z = \frac{1}{\sqrt{n-3}}$$

(Borenstein et al., 2009; Hunter & Schmidt, 2004). Because the dataset combined reported *r* values with *β*-to-*r* conversions, several safeguards were implemented to minimize transformation bias and variance inflation. First, conversion was applied only when zero-order correlations were unavailable, and all converted values were logged in a dedicated coding protocol (Borenstein et al., 2009; Peterson & Brown, 2005). Second, meta-analytic calculations were performed on Fisher's *z* values using inverse-variance weights, ensuring that high-variance estimates exerted proportionally less influence on pooled results (Cheung, 2015; Hunter & Schmidt, 2004). Third, sensitivity analyses compared the full dataset (including β-derived correlations) with a subset containing only reported zero-order correlations; structural path estimates remained stable across both versions, indicating minimal impact from the conversion process

(Rosenbusch et al., 2011; Liu et al., 2024). Finally, robust variance estimation (RVE) was employed to adjust for any heteroscedasticity or dependence arising from mixed reporting standards (Cheung, 2015; Hedges et al., 2010; Tipton, 2015).

3.4. Two-stage meta-analytic SEM procedure

In Stage 1, Fisher-z correlations were meta-analytically aggregated using multilevel random-effects models that clustered effects by StudyID and applied inverse-variance weighting. Restricted maximum likelihood (REML) yielded between-study variance (τ^2), while Cochran's Q and Higgins's I^2 quantified residual heterogeneity (Higgins & Thompson, 2002). Publication bias was assessed with Orwin's fail-safe N (Orwin, 1983) and cluster-robust Egger regressions, given their suitability for dependent effect structures. As an added robustness check, robust variance estimation (RVE) meta-regressions were conducted using Hedges' clustered estimator with small-sample corrections to explore variation in effect sizes based on variable roles, e.g. GI as predictor vs. outcome, while accounting for within-study dependencies.

Stage 2 fitted a mediation model containing direct paths from GHRM to GI, from GI to each SBP dimension (EP, EvP, SP), and to studies reporting a composite SBP score, plus direct paths from GHRM to all SBP outcomes. Composite SBP observations were treated as mutually exclusive from disaggregated dimensions to avoid double-counting. The pooled correlation matrix and its asymptotic covariance matrix, implicitly embedding τ^2, were analyzed in the metaSEM routine. Model fit was evaluated with CFI, TLI, RMSEA, and SRMR, and indirect effects were tested with Delta-method standard errors. Sensitivity analyses using sample-size weights produced substantively identical results, underscoring the robustness of the chosen estimation strategy. Publication bias was assessed using Begg and Mazumdar's rank correlation test (Begg & Mazumdar, 1994), Egger's regression test (Egger et al., 1997), and the trim-and-fill method (Duval & Tweedie, 2000). These approaches test for funnel plot asymmetry and estimate potential missing studies. Analyses were conducted using a random-effects model with restricted maximum likelihood (REML) estimation in *R*.

4. Results

4.1. Robustness test

To assess potential publication bias, we conducted Begg and Mazumdar's rank correlation test (Begg & Mazumdar, 1994), Egger's regression test (Egger et al., 1997), and the trim-and-fill procedure (Duval & Tweedie, 2000). Begg's test yielded a non-significant Kendall's τ of 0.0632 ($p = 0.1801$), suggesting no systematic association between effect sizes and their standard errors. Egger's regression test similarly showed no indication of funnel plot asymmetry ($z = 1.5695$, $p = 0.1165$), and the limit estimate as the standard error approached zero remained consistent with the overall pooled effect size ($b = 0.3138$, 95% CI [0.2247, 0.4030]). Although the funnel plot (Figure 3) appeared largely symmetrical, visual assessment can be subjective. To complement this, we applied the trim-and-fill method, which identified zero missing studies and yielded an adjusted effect size (Fisher's $z = 0.3791$) identical to the original estimate (95% CI [0.3428, 0.4155]). Collectively, these results provide converging evidence that publication bias is unlikely to be a concern in this meta-analysis, reinforcing the robustness and credibility of the findings.

4.2. Structural results and hypothesis tests

To explore the relationships among GHRM, GI, and sustainable business outcomes, we began by synthesizing zero-order correlations from 137 primary studies, yielding 210 effect sizes. Several studies contributed more than one effect size, which introduced a risk of variance inflation and statistical dependence across estimates. To address this, we employed a multilevel meta-analytic structural equation modeling (MASEM) approach that both accounts for nested data structures and enables testing of mediation effects, an advancement over traditional bivariate meta-analytic techniques.

Using Fisher's-Z transformation and inverse-variance weighting ($1/SE^2$), we generated a Stage-1 pooled correlation matrix (Table 3). GHRM was positively correlated with all four sustainability outcomes: EP ($r=0.19$), EvP ($r=0.26$), SP ($r=0.33$), and SBP (composite) ($r=0.25$). GHRM also demonstrated a strong positive association with GI ($r=0.45$). GI showed modest positive correlations with EvP ($r=0.13$) and SP ($r=0.15$), and a weak but positive link with EP ($r=0.10$). However, its correlation with SBP was small ($r=0.05$).

4.3. Stage-2 meta-analytic structural equation modeling (MASEM)

The structural model was tested in Stage 2 using random-effects two-stage structural equation modeling (TSSEM), which allowed for the integration of studies with multiple effect sizes and enabled formal testing of mediation effects. As shown in Table 2, GHRM had a significant positive effect on GI ($\beta=0.445$, SE = 0.025, $p<0.001$), supporting Hypothesis 1. This confirms that green-oriented HR practices significantly foster green innovation capability. For Hypothesis 2, GI exhibited significant positive effects on economic performance ($\beta=0.100$, SE = 0.030, $p=0.001$), environmental performance ($\beta=0.125$, SE = 0.029, $p<0.001$), and social performance ($\beta=0.153$, SE = 0.028, $p<0.001$), lending support to H2a, H2b, and H2c. However, its effect on composite sustainable business performance ($\beta=0.046$, SE = 0.029, $p=0.116$) was not statistically significant, providing no support for H2d. These results indicate that GI positively influences most sustainability outcomes, with the strongest effects on social and environmental dimensions. The model exhibited strong fit, with CFI = 0.98, TLI = 0.96, RMSEA = 0.04 (90% CI: 0.00–0.09), SRMR = 0.05, and a non-significant model test ($F(8, 120.4) = 10.47$, $p=0.23$), though residual heterogeneity remained ($Q_2(8) = 16.2$, $p=0.039$).

4.4. Direct effects analysis: GHRM on performance outcomes

In addition to its effect on GI, GHRM exerted significant direct effects on all four types of performance outcomes (Table 4), providing full support for Hypothesis 3. The results show that GHRM directly predicts economic performance ($\beta=0.192$, SE = 0.030, $p<0.001$), environmental performance ($\beta=0.258$, SE = 0.029, $p<0.001$), and social performance ($\beta=0.329$, SE = 0.028, $p<0.001$), and also has a statistically significant effect on the composite measure of sustainable business performance ($\beta=0.253$, SE = 0.029, $p<0.001$). These consistent direct effects confirm the broad impact of green HRM practices across both disaggregated and aggregated sustainability outcomes. This pattern suggests that GHRM is not only instrumental in promoting green innovation but also directly strengthens firm-level sustainability, with the strongest effects observed on social and environmental performance.

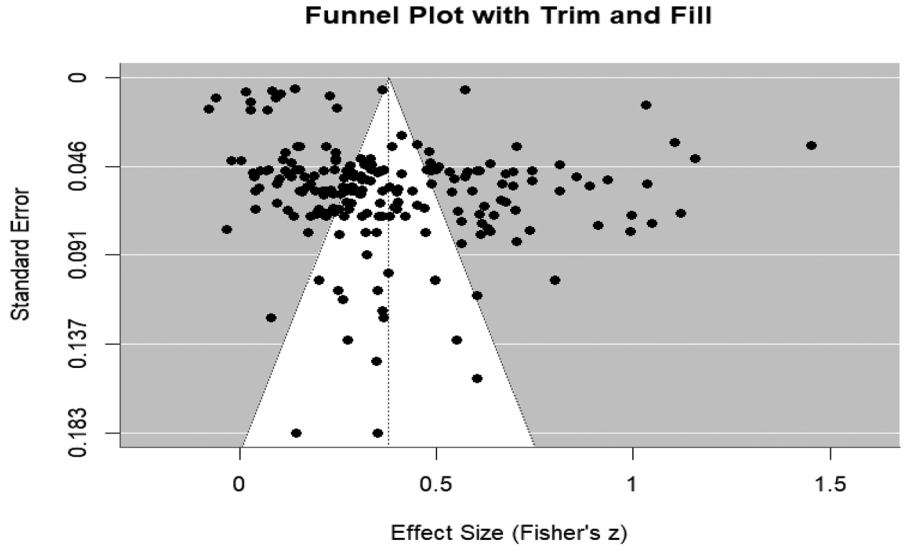


Figure 3. Funnel plot with trim and fill analysis.

Table 3. Stage-1 random-effects pooled correlation matrix.

	EP	EvP	GHRM	GI	SBP	SP
EP	1.000	−0.093	0.192	0.100	−0.075	−0.106
EvP	−0.093	1.000	0.258	0.125	−0.055	−0.140
GHRM	0.192	0.258	1.000	0.445	0.253	0.329
GI	0.100	0.125	0.445	1.000	0.046	0.153
SBP	−0.075	−0.055	0.253	0.046	1.000	−0.114
SP	−0.106	−0.140	0.329	0.153	−0.114	1.000

Note: Values are Fisher-z random-effects pooled correlations obtained with REML (inverse-variance weights). Stage-1 heterogeneity: $Q_1(15) = 134.2$, $p < 0.001$; mean $I^2 = 62\%$; τ^2 range = 0.004–0.015.

Table 4. Stage-2 TSSEM path estimates (N = 137 studies, 210 effects).

Path	β	SE	95% CI LL	95% CI UL	*t*-value	*p*-value	Sig.
GHRM → GI	0.445	0.025	0.396	0.494	18.15	<.001	***
GI → EP	0.100	0.030	0.041	0.159	3.40	0.001	**
GHRM → EP	0.192	0.030	0.133	0.251	6.50	<.001	***
GI → EvP	0.125	0.029	0.068	0.182	4.34	<.001	***
GHRM → EvP	0.258	0.029	0.200	0.316	8.96	<.001	***
GI → SP	0.153	0.028	0.098	0.208	5.50	<.001	***
GHRM → SP	0.329	0.028	0.274	0.384	11.86	<.001	***
GI → SBP (c)	0.046	0.029	−0.011	0.103	1.57	0.116	n.s.
GHRM → SBP (c)	0.253	0.029	0.196	0.310	8.63	<.001	***

SE = standard error; ns = not significant; (marginal) = $p < .10$.
*$p < .05$.
**$p < .01$.
***$p < 0.001$.
Note: Model fit (random-effects TSSEM). $F(8, 120.4) = 10.47$, $p = 0.23$; CFI = 0.98; TLI = 0.96; RMSEA = 0.04 (90% CI 0.00–0.09); SRMR = .05. Residual heterogeneity: $Q_2(8) = 16.2$, $p = 0.039$.

4.5. Mediation analysis: the role of green innovation

To explore whether GI acts as a conduit through which GHRM influences firm performance, we tested indirect paths using Stage-2 random-effects TSSEM. As shown in Table 5, GI significantly mediated the effects of GHRM on economic performance ($\beta = 0.045$, SE = 0.013, $p = 0.001$), environmental performance ($\beta = 0.056$, SE = 0.013, $p < 0.001$), and social performance ($\beta = 0.068$, SE = 0.013, $p < 0.001$), providing support for Hypotheses 4a, 4b, and 4c. However, the indirect effect on composite sustainable business performance ($\beta = 0.021$, SE = 0.013, $p = 0.117$) was not statistically significant, indicating no support for Hypothesis 4d. These results suggest that GI plays a meaningful mediating role in translating GHRM practices into specific sustainability gains, with the strongest effects observed in social and environmental dimensions, but not in composite performance outcomes.

4.6. Robustness check using robust variance estimation (RVE)

To assess the consistency and generalizability of the structural relationships tested in the Stage-2 TSSEM, a supplementary meta-regression was conducted using RVE. This approach accounts for dependencies among multiple effect sizes reported within individual studies and evaluates whether effect magnitudes vary based on the role of variables as predictors or outcomes. The RVE results, summarized in Table 6, supported the core TSSEM findings. Notably, studies modeling GHRM as a predictor of GI reported significantly stronger effect sizes (Estimate = 0.2763, $p < 0.001$), mirroring the TSSEM result where GHRM significantly predicted GI ($\beta = 0.445$, $p < 0.001$). This reinforces the theoretical proposition that GHRM plays a critical capability-building role within the RBV and AMO frameworks.

Furthermore, studies that used GI as a predictor showed significantly higher average effect sizes (Estimate = 0.1056, $p = 0.0025$), aligning with TSSEM results where GI had significant positive effects on EP, EvP, and SP, though not on the composite SBP. The RVE also revealed a marginally significant effect for EvP as a dependent variable (Estimate = 0.0800, $p = 0.0764$), partially validating the GI–EvP path in the TSSEM. However, the RVE did not detect significant effects for GI–SP and GI–SBP, suggesting possible study-level heterogeneity or context-specific variation. Collectively, these findings confirm the robustness of the model's central relationships while highlighting the added explanatory power of the TSSEM framework in detecting structured mediating effects across sustainability outcomes.

4.7. Summary of hypothesis tests for GHRM, GI, and performance outcomes

As shown in Table 7, GHRM strongly fosters GI (H1) and exerts direct positive effects on EP, EvP, and SP (H3a–H3c). GI in turn significantly predicts EP, EvP, and SP (H2a, H2b, H2c). In mediation tests, GI partially transmits the impact of GHRM to EP, EvP, and SP (H4a, H4b, H4c), whereas the indirect GHRM–GI–SBP path remains non-significant H4d.

5. Discussion

This meta-analytic structural equation modeling study advances understanding of how GHRM and GI interact to shape SBP across economic, environmental, social, and aggregate domains. Our analysis, drawing on a comprehensive pool of effect sizes from global studies, demonstrates that GI has a significant and positive effect on all three disaggregated performance dimensions: economic, environmental, and social. However, although still statistically significant, the effect on economic performance was notably smaller than for environmental and social outcomes. The composite SBP construct, by contrast, shows a near-zero correlation with GI ($r = 0.046$), indicating that equal weighting of heterogeneous outcomes can wash out meaningful variation. Accordingly, composite SBP is treated as an ancillary robustness indicator, whereas substantive inferences in this study rely on the disaggregated dimensions where theory and empirical strength converge. Composite SBP remained non-significant, likely because bundling masks domain-specific variance. These findings help reconcile mixed results reported in the growing literature on green management and innovation.

First, the significant positive effects of GHRM across economic, environmental, and social performance affirm its cross-cutting importance in sustainability transitions. This broad impact aligns closely with AMO theory and the RBV, which posit that organizational performance stems from the integration of skilled, motivated, and empowered employees (Appelbaum et al., 2001; Barney, 1991; Teece et al., 1997). Empirical studies highlight that eco-training, participative green forums, and embedded green HR policies equip employees to internalize sustainability as a shared value and daily practice (Abdallah et al., 2024; Paillé, 2024; Renwick et al., 2013). These HRM mechanisms enable firms to build green capabilities and foster a culture supportive of environmental stewardship (Ogiemwonyi et al., 2023; Sobaih et al., 2020; Yang & Li, 2023). Although GHRM significantly improved all performance dimensions, its effect sizes were largest for social and environmental outcomes, suggesting that economic returns may emerge more indirectly through operational improvements (Awwad Al-Shammari et al., 2022; Carballo-Penela et al., 2023).

Table 5. Stage-2 random-effects TSSEM: Indirect (mediated) effects.

Indirect path	β	SE	95% CI LL	95% CI UL	*t*-value	*p*-value	Sig.
GHRM → GI → EP	0.045	0.013	0.020	0.070	3.34	0.001	**
GHRM → GI → EvP	0.056	0.013	0.031	0.081	4.22	<.001	***
GHRM → GI → SP	0.068	0.013	0.043	0.093	5.26	<.001	***
GHRM → GI → SBP (c)	0.021	0.013	−0.004	0.046	1.57	0.117	n.s.

SE = standard error; ns = not significant; (marginal) = $p < .10$.
*$p < .05$.
**$p < .01$.
***$p < 0.001$.

Table 6. Robust variance estimation (RVE) meta-regression results for predictor and outcome roles.

Predicator	Estimate (Fisher's *z*)	SE	*t*-stat	df	*p*-value	Significance
Intercept	0.2624	0.0435	6.029	38.0	<.001	***
var1GI	0.1056	0.0335	3.152	61.9	0.0025	**
var2EvP	0.0800	0.0443	1.805	56.9	0.0764	(marginal)
var2GI	0.2763	0.0611	4.521	56.8	<.001	***
var2SBP	0.0312	0.0497	0.629	56.9	0.5318	ns
var2SP	0.0798	0.1028	0.777	11.2	0.4534	ns

SE = standard error; df = degrees of freedom (Satterthwaite adjusted); ns = not significant; (marginal) = $p < .10$.
*$p < .05$.
**$p < .01$.
***$p < 0.001$.

A particularly salient finding is the strong, consistent pathway from GHRM to GI, reinforcing the critical role of human-capital investment in driving environmental innovation (Aftab et al., 2023; Almeida & Wasim, 2023). Theoretically, this pathway is explained by both RBV and TPB. GHRM creates valuable, rare, and inimitable green knowledge and routines, enabling firms to sustain competitive advantage through innovation (Achmad et al., 2023; Barney, 1991; Carballo-Penela et al., 2023; Teece et al., 1997). Simultaneously, GHRM shapes pro-environmental attitudes and behavioral intentions across the workforce, creating fertile ground for the diffusion of innovative practices (Ajzen, 1991; Fang et al., 2022; Song et al., 2022). Our results confirm that GI significantly mediates the relationship between GHRM and all three disaggregated outcomes. It is worth noting, however, that the direct GI–EP coefficient ($\beta = 0.10$) falls within the "small-effect" range (Cohen, 1988). Statistical significance here reflects the cumulative sample (167,000 observations) rather than a transformational financial impact; firms aiming for sizeable bottom-line gains must pair green innovation with complementary levers such as cost-sharing alliances, digital efficiency programs, or targeted green-finance instruments. These patterns were triangulated by RVE meta-regression results, which revealed consistently larger effect sizes for studies modeling GI as either predictor or outcome, while showing weaker or non-significant effects for aggregate SBP.

Our meta-analysis confirms GI's selective strength across sustainability dimensions. The strongest mediation effects were observed for environmental and social performance patterns widely supported in existing literature (Mahmood & Nasir, 2023; Zihan & Makhbul, 2024). GI improves resource efficiency, waste reduction, and emissions outcomes, while also enhancing social legitimacy through employee engagement, customer trust, and reputational value (Baeshen et al., 2021; Mahmood & Nasir, 2023; TantayanubuZihan and Makhbul 2024Zihan and Makhbul 2024tr & Panjakajornsak, 2017). Although economic mediation was significant, it was more modest. For instance, Zhang et al. (2019) found financial gains primarily in state-owned firms with strong regulatory backing. These findings suggest that economic returns from GI are conditional on firm type, institutional environment, and innovation form. In OECD settings, compliance-driven R&D showed substantial environmental benefits but only partial short-term financial returns (Lanoie et al., 2011; Wagner, 2010).

The lack of a significant relationship between GI and the composite SBP index also warrants attention. This likely reflects a bundling effect, where combining multiple outcome dimensions with unequal effect sizes and measurement inconsistency can dilute true domain-specific impacts. Since GI's influence is stronger on environmental and social dimensions and weaker on economic outcomes, composite SBP aggregates may obscure the variance across categories. A measurement approach that applies theory-based weights or reports each dimension separately offers a clearer view of innovation payoffs and avoids giving disproportionate influence to outcomes that change slowly or in opposite directions. This supports earlier warnings that composite metrics, especially those dominated by financial indicators, can misrepresent targeted impacts of specific interventions like GI. Disaggregated reporting remains critical for accurate sustainability assessment.

Importantly, our synthesis provides robust confirmation that GI is a pivotal mechanism linking GHRM to environmental, social, and economic performance. The AMO–TPB–RBV framework offers a compelling

Table 7. Summary of hypothesis tests for GHRM, GI, and performance outcomes.

Hypothesis	Path	β	Support
H1	GHRM → GI	0.445	Supported
H2a	GI → EP	0.100	Supported
H2b	GI → EvP	0.125	Supported
H2c	GI → SP	0.153	Supported
H2d	GI → SBP (c)	0.046	Not supported
H3a	GHRM → EP	0.192	Supported
H3b	GHRM → EvP	0.258	Supported
H3c	GHRM → SP	0.329	Supported
H3d	GHRM → SBP (c)	0.253	Supported
H4a	GHRM → GI → EP	0.045	Supported
H4b	GHRM → GI → EvP	0.056	Supported
H4c	GHRM → GI → SP	0.068	Supported
H4d	GHRM → GI → SBP (c)	0.021	Not supported

explanation: GHRM enhances both employee capabilities and motivation, which catalyze the adoption of GI, producing measurable outcomes (Ahakwa et al., 2021; Almeida & Wasim, 2023; de Sousa Jabbour et al., 2015; Paillé, 2024). This pattern holds across diverse contexts, including Pakistan, India, Malaysia, China, and OECD countries, where GI mediates the GHRM–EvP and GHRM–SP links. Targeted green training, cross-functional collaboration, and supportive leadership are identified as key enablers (Abu Seman et al., 2019; Aftab et al., 2023; Afzal et al., 2023; Alshuaibi et al., 2024; Bahmani et al., 2023; Chau et al., 2023; Fang et al., 2022; Kanan et al., 2023; Rana & Arya, 2024).

Though GI significantly mediates economic performance, its relatively smaller impact underscores the importance of contextual alignment. Studies reporting stronger financial effects from GI typically feature enabling conditions such as regulatory incentives, advanced supply chains, or access to green finance (Zhang et al., 2019; Bahmani et al., 2023). In contrast, resource-constrained SMEs or firms in weaker institutional environments may face delayed or uncertain returns. A nuanced reading of the evidence therefore, treats green innovation as a necessary but insufficient driver of profitability, its financial value crystallizes when complementary assets and supportive policies are present. This explains why many studies still describe economic outcomes as conditional or emergent.

In sum, this meta-analytic synthesis reconciles prior inconsistencies in the GHRM–GI–SBP literature. While GI is essential for driving environmental and social improvements and contributes meaningfully to economic performance, its full potential depends on enabling institutional and organizational contexts. GHRM remains the most consistent and foundational enabler of sustainability and innovation. These findings highlight the strategic importance of HR systems as core drivers of sustainable transformation across firms and industries.

5.1. Implications

5.1.1. Practical implications

For business leaders and HR professionals, the key takeaway is that green HRM should be positioned as a strategic function, not a peripheral one. Embedding sustainability into core HR practices—job design, recruitment, onboarding, performance appraisals, training, and rewards can significantly improve a firm's environmental, social, and financial outcomes. This includes updating job descriptions to reflect green values, delivering tailored green training during onboarding, and embedding sustainability goals into performance evaluations. Firms can also design reward and recognition schemes to celebrate staff who lead or contribute to green improvements. These HR levers not only support compliance and reduce environmental risk, but also build staff engagement, drive innovation, and strengthen relationships with customers and investors.

Application varies by firm profile. SMEs can start with low-cost steps, such as launching short micro-learning modules on energy efficiency, adding a simple environmental contribution box in annual appraisals, or assigning a part-time green champion. Larger firms in carbon-intensive industries can embed environmental KPIs across management levels for instance, linking 15 percent of executive bonuses to carbon-intensity reduction, and offer tiered reward programmes that grant frontline teams cash or time-off for meeting recycling targets. Service-sector firms may integrate eco-nudges like virtual meeting targets, e-bike commuting incentives, and double-sided printing defaults into HR wellness programs. In the EU, firms can align training content with Corporate Sustainability Reporting Directive (CSRD) metrics, while companies in emerging economies may benefit from linking green recognition awards to voluntary ISO 14001 benchmarks or national eco-labelling schemes.

Green innovation translates these HR efforts into measurable gains. Managers should pilot low-waste processes, invest in scalable green technologies, and encourage employee-led innovation. Industry-specific strategies help maximize returns. Food processors can prioritize water reuse and waste-to-energy projects; electronics firms may focus on closed-loop materials recovery; hospitality businesses often benefit quickly from lighting retrofits and linen reuse programmes. Cross-functional "green squads" can be tasked with testing and scaling such initiatives, with achievements reflected in job profiles, appraisals, and recognition platforms. Firms that nurture a culture of sustainability will be more agile and competitive as environmental expectations continue to rise.

5.1.2. Theoretical implications

This study contributes to theory by integrating and empirically validating three foundational perspectives AMO theory, the TPB, and the RBV within a unified meta-analytic SEM framework. The findings affirm that GHRM is not merely a collection of HR practices, but a strategic capability that shapes sustainability outcomes across multiple levels. From the AMO lens, GHRM equips employees with the necessary skills, motivation, and opportunities to pursue environmental and social goals. TPB complements this by illustrating how GHRM influences pro-environmental attitudes, subjective norms, and perceived behavioral control, which together foster green behavioral intentions. RBV, meanwhile, positions both GHRM and Green Innovation (GI) as valuable, rare, and inimitable organizational capabilities that contribute to sustained competitive advantage through improved sustainability performance.

Importantly, the study validates the theoretical convergence of AMO, TPB, and RBV by confirming that GI significantly mediates the relationship between GHRM and economic, environmental, and social performance. This supports the view that GHRM activates green innovation through its influence on employee behavior and capability, leading to measurable organizational gains. However, the comparatively smaller mediation effect on economic performance suggests that GI's value may be more gradual or indirect in financial domains. Rather than challenging theoretical assumptions, this nuance underscores the need to account for timing, implementation maturity, and contextual moderators such as firm size, industry type, or regulatory environment. Additionally, the non-significant effect of GI on composite SBP highlights the limitations of bundled performance metrics, which may conceal differentiated pathways. By disaggregating sustainability outcomes, this study reinforces the relevance of integrated, multilevel theoretical models and encourages future research to investigate reciprocal causality, feedback loops, and boundary conditions that shape the sustainability–innovation–performance nexus.

5.1.3. Policy implications

For policymakers and public-sector actors, these findings suggest that advancing firm-level sustainability requires investment in people as much as in technology. National and regional programs should include tax credits, grants, or recognition schemes for firms adopting green HRM. Workforce development programs must integrate environmental literacy for managers and staff, building the human capital essential for green transitions. Governments can also support cross-sector innovation hubs to facilitate peer learning and promote alignment between HR, sustainability, and innovation strategies. These approaches directly advance the United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work), SDG 9 (Innovation), SDG 12 (Sustainable Consumption), and SDG 13 (Climate Action). Embedding green HRM in enterprise support policies can accelerate both climate targets and inclusive economic growth. Recognizing that economic returns from green innovation may take time, especially for SMEs governments should offer transitional support such as training subsidies or pilot funding. Ultimately, this study affirms that sustainable performance begins with people. Firms that invest in green HRM, reward sustainable behavior, and foster innovation-friendly cultures are better equipped to adapt and thrive in a future where sustainability is no longer optional but a prerequisite for success.

7. Conclusion

This study provides strong meta-analytic evidence that GHRM is a key driver of SBP across economic, environmental, and social dimensions. Drawing on 137 studies and 210 effect sizes through a two-stage MASEM approach, we show that GHRM exerts consistent direct effects on all facets of SBP and operates indirectly through GI to enhance each disaggregated outcome. These findings affirm the value of integrating AMO theory, the Theory of Planned Behavior, and the RBV to explain how HR systems foster innovation and sustainability. GHRM thus emerges as a strategic capability for firm-level transformation, rather than a peripheral HR function.

Importantly, our results reveal that GI significantly mediates the effects of GHRM on environmental, social, and economic performance, though its effect on economic outcomes is comparatively smaller.

Additionally, GI does not significantly influence composite SBP, likely due to bundled measures that mask domain-specific contributions. This nuanced insight challenges assumptions of uniform financial returns from green innovation and underscores the importance of strategic alignment, complementary capabilities, and measurement precision. By demonstrating GHRM's dual role as a direct lever for sustainability and an indirect enabler of innovation, this study provides clear guidance for managers, theoretical advancement for scholars, and actionable insights for policymakers seeking to link human capital development with long-term sustainability goals.

8. Limitations and future research directions

This meta-analysis provides important insights into how GHRM and GI interact to shape SBP. However, several limitations must be acknowledged. Although the use of meta-analytic structural equation modeling strengthens causal inference, the findings remain correlational. The direction of relationships, especially the mediating role of GI, cannot be definitively established without longitudinal or experimental designs. Additionally, some studies were excluded due to incomplete statistical reporting, missing reliability coefficients, or limited database access, which may have introduced selection bias. Gray literature, such as dissertations and non-indexed reports, was also excluded, potentially limiting the comprehensiveness of the evidence base despite the use of statistical techniques to assess publication bias.

A second limitation concerns construct specification. This analysis treated GI as a unified construct, potentially overlooking important differences between green product, process, and organizational innovations. Similarly, SBP was often measured as an aggregate outcome, masking the distinct effects on its economic, environmental, and social dimensions. Because the three SBP pillars differ in reliability, lag structure, and effect magnitude, an unweighted composite correlated only trivially with GI ($r = 0.046$); the index was therefore retained solely as a robustness check, and substantive interpretations were based on the disaggregated dimensions. Future studies should apply theory-driven weights or report each pillar separately to avoid measurement dilution and to clarify how green innovation creates value. Disaggregating these constructs in future work could help clarify which specific HRM practices drive which sustainability outcomes, such as waste reduction, energy efficiency, or employee well-being. Moreover, the focus on GHRM as the sole antecedent of GI excluded other important environmental practices, such as Internal Environmental Management (IEM), which includes energy conservation, pollution control, and waste-reduction strategies that are known to influence innovation capacity.

Source coverage represents another constraint. The study pool is dominated by English-language, peer-reviewed journal articles, while non-English publications, conference papers, and other gray literature, particularly from emerging economies, are under-represented. Expanding language filters, mining institutional repositories, and refreshing empirical baselines would enhance global representativeness and ensure that recent policy and technological shifts are fully reflected.

Finally, the study did not account for potential moderators that may condition the strength or direction of observed relationships. In particular, Digital Orientation (DO), a firm's readiness to integrate digital tools into operations, may play a significant role in enhancing or constraining the effects of GHRM and GI on SBP, but was not consistently reported across studies. Other contextual factors such as firm size, industry type, regulatory environment, and national culture also remain underexplored, especially in developing economies like those in Sub-Saharan Africa, Southeast Asia, and Latin America. Future research should address these gaps by incorporating such moderators, exploring feedback loops between sustainability performance and HRM practices, and adopting longitudinal approaches to uncover the dynamic evolution of green capabilities over time.

Acknowledgments

We extend our gratitude to Mbarara University of Science and Technology and the University of Doha for Science and Technology for providing access to scholarly articles and research resources.

Authors' contributions

CRediT: **Dedrix Stephenson Bindeeba**: Conceptualization, Data curation, Formal analysis, Visualization, Writing – original draft; **Rennie Bakashaba**: Data curation, Formal analysis, Methodology, Validation, Writing – original draft; **Eddy Kurobuza Tukamushaba**: Formal analysis, Methodology, Supervision, Writing – review & editing; **Susan Atuhaire**: Conceptualization, Validation, Visualization, Writing – original draft, Writing – review & editing.

Disclosure statement

The authors declare no conflicts of interest regarding the publication of this manuscript.

Data availability

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

Funding

No funding was received for this study.

About the authors

Dedrix Stephenson Bindeeba is a PhD student at the Faculty of Business and Management Sciences, Mbarara University of Science and Technology, Uganda. He holds an MBA in Big Data Management and a Master's degree in Monitoring and Evaluation. His research focuses on the intersection of digital transformation and sustainable business practices, emphasizing cleaner production, sustainable entrepreneurship, and the role of human capital in fostering green innovation and organizational sustainability.

Rennie Bakashaba holds a PhD in Economics and an MSc in International Business and Finance. He is a Senior Lecturer at the Faculty of Business and Management Sciences, Mbarara University of Science and Technology. His research focuses on entrepreneurship, the theory of the firm, barriers to SME growth, and the sustainable development of small and medium-sized enterprises in emerging economies.

Prof. Eddy Kurobuza Tukamushaba is a Professor of Sustainable Tourism Management at the University of Doha for Science and Technology and the Chief Executive Officer of TIMEL Hospitality Consult Ltd in Uganda. His expertise spans sustainable business management, digital business transformation, circular economy practices, cleaner production, and hospitality and tourism management. He has published extensively in leading journals and received multiple best paper awards at international conferences. His current research focuses on digital business for sustainable development, sustainable consumer behavior, and circular economy approaches that foster environmentally responsible and resilient business practices.

Susan Atuhaire is a Human Resources expert with an MBA and extensive experience in implementing HR strategies that drive organizational growth through workforce optimization. She has a strong background in aligning HR practices with business goals to enhance performance, innovation, and employee engagement. Her research interests focus on leveraging human resource management to achieve organizational sustainability, foster long-term value creation, and support environmentally and socially responsible business practices.

ORCID

Dedrix Stephenson Bindeeba http://orcid.org/0009-0001-8334-206X
Rennie Bakashaba http://orcid.org/0009-0008-8310-402X
Eddy Kurobuza Tukamushaba http://orcid.org/0000-0002-8110-6581
Susan Atuhaire http://orcid.org/0009-0002-0190-4952

References

Abdallah, A. B., Al-Ghwayeen, W. S., Al-Amayreh, E. M., & Sweis, R. J. (2024). The impact of green supply chain management on circular economy performance: The mediating roles of green innovations. *Logistics*, *8*(1), 20. https://doi.org/10.3390/logistics8010020

Abu Seman, N. A., Govindan, K., Mardani, A., Zakuan, N., Mat Saman, M. Z., Hooker, R. E., & Ozkul, S. (2019). The mediating effect of green innovation on the relationship between green supply chain management and environmental performance. *Journal of Cleaner Production*, *229*, 115–127. https://doi.org/10.1016/j.jclepro.2019.03.211

Achmad, G. N., Yudaruddin, R., Budiman, P. W., Nor Santi, E., Suharsono, Purnomo, A. H., & Wahyuningsih, N. (2023). Eco-innovation and SME performance in time of covid-19 pandemic: moderating role of environmental collaboration. *Emerging Science Journal*, *7*(2), 251–263. https://doi.org/10.28991/ESJ-2023-SPER-018

Acquah, I. S. K., Agyabeng-Mensah, Y., & Afum, E. (2021). Examining the link among green human resource management practices, green supply chain management practices and performance. *Benchmarking: An International Journal*, *28*(1), 267–290. https://doi.org/10.1108/BIJ-05-2020-0205

Aftab, J., Abid, N., Cucari, N., & Savastano, M. (2023). Green human resource management and environmental performance: The role of green innovation and environmental strategy in a developing country. *Business Strategy and the Environment*, *32*(4), 1782–1798. https://doi.org/10.1002/bse.3219

Afzal, C. M., Khan, S. N., Baig, F. J., & Ashraf, M. U. (2023). Impact of green human resource management on environmental performance: The mediating role of green innovation and environmental strategy in Pakistan. *Review of Applied Management and Social Sciences*, *6*(2), 227–242. https://doi.org/10.47067/ramss.v6i2.311

Aggarwal, M., Dutta, M., Madaan, V., Pham, L. T., & Lourens, M. (2023). Impact of green human resource management on sustainable performance. *E3S Web of Conferences*, *399*, 07005. https://doi.org/10.1051/e3sconf/202339907005Ahakwa, I., Yang, J., Agba Tackie, E., & Asamany, M. (2021). Green human resource management practices and environmental performance in Ghana: The role of green innovation. *SEISENSE Journal of Management*, *4*(4), 100–119. https://doi.org/10.33215/sjom.v4i4.704

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ali, S., Ali, A. J., Ashfaq, K., & Khalid, J. (2021). Green human resource management and environmental innovativeness. *International Journal of Sustainable Development and Planning*, *16*(6), 1117–1130. https://doi.org/10.18280/ijsdp.160613

Almeida, F., & Wasim, J. (2023). Eco-innovation and sustainable business performance: Perspectives of SMEs in Portugal and the UK. *Society and Business Review*, *18*(1), 28–50. https://doi.org/10.1108/SBR-12-2021-0233

Aloqaily, A. N. (2023). The effects green human resource on employees' green voice behaviors towards green innovation. *ABAC Journal*, *43*(4). https://doi.org/10.59865/abacj.2023.62

Alshuaibi, M. S. I., Alhebri, A., Khan, S. N., & Sheikh, A. A. (2024). Big data analytics, GHRM practices, and green digital learning paving the way towards green innovation and sustainable firm performance. *Journal of Open Innovation: Technology, Market, and Complexity*, *10*(4), 100396. https://doi.org/10.1016/j.joitmc.2024.100396

Anwar, M., & Shah, S. Z. A. (2021). Entrepreneurial orientation and generic competitive strategies for emerging SMEs: Financial and nonfinancial performance perspective. *Journal of Public Affairs*, *21*(1). https://doi.org/10.1002/pa.2125

Appelbaum, E., Bailey, T., Berg, P., & Kalleberg, A. L. (2001). Do high performance work systems pay off? *Research in the Sociology of Work*, *10*, 85–107. https://doi.org/10.1016/s0277-2833(01)80022-4

Awwad Al-Shammari, A. S., Alshammrei, S., Nawaz, N., & Tayyab, M. (2022). Green human resource management and sustainable performance with the mediating role of green innovation: a perspective of new technological era. *Frontiers in Environmental Science*, *10*. https://doi.org/10.3389/fenvs.2022.901235

Baeshen, Y., Soomro, Y. A., & Bhutto, M. Y. (2021). Determinants of green innovation to achieve sustainable business performance: evidence from SMEs. *Frontiers in Psychology*, *12*, 767968. https://doi.org/10.3389/fpsyg.2021.767968

Bahmani, S., Farmanesh, P., & Khademolomoom, A. H. (2023). Effects of green human resource management on innovation performance through green innovation: Evidence from northern cyprus on small island universities. *Sustainability (Switzerland)*, *15*(5), 4158. https://doi.org/10.3390/su15054158

Bai, Y., Song, S., Jiao, J., & Yang, R. (2019). The impacts of government R&D subsidies on green innovation: Evidence from Chinese energy-intensive firms. *Journal of Cleaner Production*, *233*, 819–829. https://doi.org/10.1016/j.jclepro.2019.06.107

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Begg, C. B., & Mazumdar, M. (1994). Operating characteristics of a rank correlation test for publication bias. *Biometrics*, *50*(4), 1088–1101. https://doi.org/10.2307/2533446

Bindeeba, D. S., Tukamushaba, E. K., & Bakashaba, R. (2025). Digital transformation and its multidimensional impact on sustainable business performance: Evidence from a meta-analytic review. *Future Business Journal*, *11*(1), 90. https://doi.org/10.1186/s43093-025-00511-z

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. John Wiley & Sons.

Brunel, C. (2019). Green innovation and green imports: Links between environmental policies, innovation, and production. *Journal of Environmental Management*, *248*, 109290. https://doi.org/10.1016/j.jenvman.2019.109290

Carballo-Penela, A., Ruzo-Sanmartín, E., Álvarez-González, P., & Paillé, P. (2023). How do GHRM practices influence firms' economic performance? A meta-analytic investigation of the role of GSCM and environmental performance. *Journal of Business Research*, *165*, 113984. https://doi.org/10.1016/j.jbusres.2023.113984

Chau, K. Y., Huang, T., Moslehpour, M., Khan, W., Nisar, Q. A., & Haris, M. (2023). Opening a new horizon in green HRM practices with big data analytics and its analogy to circular economy performance: An empirical evidence. *Environment, Development and Sustainability*, *26*(5), 12133–12162. https://doi.org/10.1007/s10668-023-03725-9

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics*, *67*(4), 331–339. https://doi.org/10.1007/s10551-006-9025-5

Cheung, M. W. L. (2015). *Meta-analysis: A structural equation modeling approach*. Wiley. https://doi.org/10.1002/9781118957813

Cheung, M. W. L., & Chan, W. (2004). Meta-analytic structural equation modeling: A two-stage approach. *Psychological Methods*, *9*(1), 40–64. https://doi.org/10.1037/1082-989X.9.1.40

Chiou, T. Y., Chan, H. K., Lettice, F., & Chung, S. H. (2011). The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transportation Research Part E: Logistics and Transportation Review*, *47*(6), 822–836. https://doi.org/10.1016/j.tre.2011.05.016

Chughtai, M. A., Haq, S. U., Arshad, R., & Tamimi, S. (2024). Application of green HRM and its impact on environmental performance: A case of construction projects. *International Journal of Business Environment*, *15*(1), 41–62. https://doi.org/10.1504/IJBE.2024.10061183

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. (2nd ed.). Lawrence Erlbaum Associates.

de Sousa Jabbour, A. B. L., Frascareli, F. C. D. O., & Jabbour, C. J. C. (2015). Green supply chain management and firms' performance: Understanding potential relationships and the role of green sourcing and some other green practices. *Resources, Conservation and Recycling*, *104*, 366–374. https://doi.org/10.1016/j.resconrec.2015.07.017

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, *56*(2), 455–463. https://doi.org/10.1111/j.0006-341X.2000.00455.x

Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ (Clinical Research ed.)*, *315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629

Fang, L., Shi, S., Gao, J., & Li, X. (2022). The mediating role of green innovation and green culture in the relationship between green human resource management and environmental performance. *PloS One*, *17*(9), e0274820. https://doi.org/10.1371/journal.pone.0274820

Fernando, Y., Chiappetta Jabbour, C. J., & Wah, W. X. (2019). Pursuing green growth in technology firms through the connections between environmental innovation and sustainable business performance: Does service capability matter? *Resources, Conservation and Recycling*, *141*, 8–20. https://doi.org/10.1016/j.resconrec.2018.09.031

Friend, A. J., Sinha, I. P., & Thomas, P. W. (2020). Interrater reliability in systematic reviews: A practical guide. *Systematic Reviews*, *9*, 200. https://doi.org/10.1186/s13643-020-01435-9

García-Machado, J. J., & Martínez-Ávila, M. (2019). Environmental performance and green culture: The mediating effect of green innovation. An application to the automotive industry. *Sustainability*, *11*(18), 4874. https://doi.org/10.3390/su11184874

Guang-Wen, Z., & Siddik, A. B. (2023). The effect of Fintech adoption on green finance and environmental performance of banking institutions during the COVID-19 pandemic: The role of green innovation. *Environmental Science and Pollution Research International*, *30*(10), 25959–25971. https://doi.org/10.1007/s11356-022-23956-z

Hedges, L. V., Tipton, E., & Johnson, M. C. (2010). Robust variance estimation in meta-regression with dependent effect size estimates. *Research Synthesis Methods*, *1*(1), 39–65. https://doi.org/10.1002/jrsm.5

Higgins, J. P. T., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine*, *21*(11), 1539–1558. https://doi.org/10.1002/sim.1186

Hizarci-Payne, A. K., İpek, İ., & Kurt Gümüş, G. (2021). How environmental innovation influences firm performance: A meta-analytic review. *Business Strategy and the Environment*, *30*(2), 1174–1190. https://doi.org/10.1002/bse.2678

Hunter, J. E., & Schmidt, F. L. (2004). *Methods of meta-analysis: correcting error and bias in research findings*. (2nd ed.). Sage Publications.

Imran, R., Alraja, M. N., & Khashab, B. (2023). Sustainable performance and green innovation: green human resources management and big data as antecedents. *IEEE Transactions on Engineering Management*, *70*(12), 4191–4206. https://doi.org/10.1109/TEM.2021.3114256

Jackson, S. E., Renwick, D. W. S., Jabbour, C. J. C., & Muller-Camen, M. (2011). State-of-the-art and future directions for green human resource management: Introduction to the special issue. *German Journal of Human Resource Management: Zeitschrift Für Personalforschung*, *25*(2), 99–116. https://doi.org/10.1177/239700221102500203

Kanan, M., Taha, B., Saleh, Y., Alsayed, M., Assaf, R., Hassen, M., Ben, Alshaibani, E., Bakir, A., & Tunsi, W. (2023). Green innovation as a mediator between green human resource management practices and sustainable performance in palestinian manufacturing industries. *Sustainability*, *15*(2), 1077. https://doi.org/10.3390/su15021077

Karimi Takalo, S., Sayyadi Tooranloo, H., & Shahabaldini Parizi, Z. (2021). Green innovation: A systematic literature review. In *Journal of Cleaner Production* (Vol. 279). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2020.122474

Khan, K., Gogia, E. H., Shao, Z., Rehman, M. Z., & Ullah, A. (2025). The impact of green HRM practices on green innovative work behaviour: Empirical evidence from the hospitality sector of China and Pakistan. *BMC Psychology*, *13*(1), 96. https://doi.org/10.1186/s40359-025-02417-5

Khan, M. T., Idrees, M. D., & Haider, Y. (2024). Industry 4.0 impacts on operational and green innovation performances with the mediation of green practices. *International Journal of Productivity and Performance Management*, *73*(5), 1405–1426. https://doi.org/10.1108/IJPPM-06-2022-0277

Kuzma, E., Padilha, L. S., Sehnem, S., Julkovski, D. J., & Roman, D. J. (2020). The relationship between innovation and sustainability: A meta-analytic study. *Journal of Cleaner Production*, *259*, 120745. https://doi.org/10.1016/j.jclepro.2020.120745

Lanoie, P., Laurent-Lucchetti, J., Johnstone, N., & Ambec, S. (2011). Environmental policy, innovation and performance: New insights on the porter hypothesis. *Journal of Economics & Management Strategy*, *20*(3), 803–842. https://doi.org/10.1111/j.1530-9134.2011.00301.x

Lewandowska, M. S., Gołębiowski, T., & Rószkiewicz, M. (2022). Eco-innovation, international competitiveness and economic performance of European Union enterprises: Triangle approach. *European Research Studies Journal*, *XXV*(Issue 1).
Li, Y., Dai, J., & Cui, L. (2020). The impact of digital technologies on economic and environmental performance in the context of industry 4.0: A moderated mediation model. *International Journal of Production Economics*, *229*, 107777. https://doi.org/10.1016/j.ijpe.2020.107777
Li, Y., Ding, R., & Sun, T. (2019). The drivers and performance of environmental practices in the Chinese construction industry. *Sustainability*, *11*(3), 614. https://doi.org/10.3390/su11030614
Li, Z., & Li, M. (2025). Does environmental, social, and governance performance affect corporate green innovation? Evidence from China. *Polish Journal of Environmental Studies*, *34*(3), 2273–2283. https://doi.org/10.15244/pjoes/187600
Li, H., Li, Y., Sarfarz, M., & Ozturk, I. (2023). Enhancing firms' green innovation and sustainable performance through the mediating role of green product innovation and moderating role of employees' green behavior. *Economic Research-Ekonomska Istraživanja*, *36*(2). https://doi.org/10.1080/1331677X.2022.2142263
Lin, ZI., Gu, HAI., Gillani, K. Z., & Fahlevi, M. (2024). Impact of Green Work–Life Balance and Green Human Resource Management Practices on Corporate Sustainability Performance and Employee Retention: Mediation of Green Innovation and Organisational Culture. *Sustainability*, *16*(15), 6621 https://doi.org/10.3390/su16156621
Liu, M., Liu, L., & Feng, A. (2024). The impact of green innovation on corporate performance: An analysis based on substantive and strategic green innovations. *Sustainability*, *16*(6), 2588. https://doi.org/10.3390/su16062588
Mahmood, F., & Nasir, N. (2023). Impact of green human resource management practises on sustainable performance: Serial mediation of green intellectual capital and green behaviour. *Environmental Science and Pollution Research International*, *30*(39), 90875–90891. https://doi.org/10.1007/s11356-023-28541-6
Makumbe, W. (2024). Green human resources management and green performance: A mediation–moderation mechanism for green innovation and green knowledge sharing. *Sustainability*, *16*(24), 10849. https://doi.org/10.3390/su162410849
Maldonado Guzmám, G., & Pinzón Castro, S. Y. (2023). Collaboration, eco-innovation and economic performance in the automotive industry. *International Journal of Industrial Engineering and Operations Management*, *5*(3), 200–219. https://doi.org/10.1108/IJIEOM-09-2022-0041
Miah, M., Szabó-Szentgróti, G., & Walter, V. (2024). A systematic literature review on green human resource management (GHRM): an organizational sustainability perspective. In *Cogent Business and Management* (Vol. 11, Issue 1). Cogent OA. https://doi.org/10.1080/23311975.2024.2371983
Munawar, S., Yousaf, D. H. Q., Ahmed, M., & Rehman, D. S. (2022). Effects of green human resource management on green innovation through green human capital, environmental knowledge, and managerial environmental concern. *Journal of Hospitality and Tourism Management*, *52*, 141–150. https://doi.org/10.1016/j.jhtm.2022.06.009
Mustafa, F., Arshad, S., Iqbal, A., & Khan, S. N. (2022). The influence of green HRM on environmental performance: The mediating effect of green innovation and moderating effect of environmental strategy. *International Journal of Business and Economic Affairs*, *7*(4). https://doi.org/10.24088/IJBEA-2022-74003
Obeng, P., Dogbe, C. S. K., & Boahen, P. A. N. (2023). Nexus between GHRM and organizational competitiveness: Role of green innovation and organizational learning of MNEs. *Business and Society Review*, *128*(2), 275–303. https://doi.org/10.1111/basr.12310
Oduro, S. (2024). Eco-innovation and SMEs' sustainable performance: A meta-analysis. *European Journal of Innovation Management*, *27*(9), 248–279. https://doi.org/10.1108/EJIM-11-2023-0961
Ogiemwonyi, O., Alam, M. N., & Alotaibi, H. S. (2023). Pathways toward environmental performance: Link between green human resource management, green innovation, and green behavior at work in manufacturing companies. *Journal of Cleaner Production*, *425*, 138949. https://doi.org/10.1016/j.jclepro.2023.138949
Orwin, R. G. (1983). A fail-safe N for effect size in meta-analysis. *Journal of Educational Statistics*, *8*(2), 157–159. https://doi.org/10.3102/10769986008002157
Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews*, *10*(1). https://doi.org/10.1186/s13643-021-01626-4
Paillé, P. (2024). Green human resource practices for individual environmental performance: A meta-review. *Canadian Journal of Administrative Sciences*, https://doi.org/10.1002/cjas.1768
Peng, M. Y. P., Zhang, L., Lee, M. H., Hsu, F. Y., Xu, Y., & He, Y. (2024). The relationship between strategic human resource management, green innovation and environmental performance: A moderated-mediation model. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-02754-7
Perez, J. A. E., Ejaz, F., & Ejaz, S. (2023). Green transformational leadership, GHRM, and proenvironmental behavior: an effectual drive to environmental performances of small- and medium-sized enterprises. *Sustainability*, *15*(5), 4537. https://doi.org/10.3390/su15054537
Peterson, R. A., & Brown, S. P. (2005). On the use of beta coefficients in meta-analysis. *The Journal of Applied Psychology*, *90*(1), 175–181. https://doi.org/10.1037/0021-9010.90.1.175
Przychodzen, W., Leyva-de La Hiz, D. I., & Przychodzen, J. (2020). First-mover advantages in green innovation—Opportunities and threats for financial performance: A longitudinal analysis. *Corporate Social Responsibility and Environmental Management*, *27*(1), 339–357. https://doi.org/10.1002/csr.1809

Rana, G., & Arya, V. (2024). Green human resource management and environmental performance: Mediating role of green innovation—a study from an emerging country. *foresight*, *26*(1), 35–58. https://doi.org/10.1108/FS-04-2021-0094

Rawashdeh, A. M. (2018). The impact of green human resource management on organizational environmental performance in Jordanian health service organizations. *Management Science Letters*, 1049–1058. https://doi.org/10.5267/j.msl.2018.7.006

Raza, Z. (2020). Effects of regulation-driven green innovations on short sea shippinǵs environmental and economic performance. *Transportation Research Part D: Transport and Environment*, *84*, 102340. https://doi.org/10.1016/j.trd.2020.102340

Renwick, D. W. S., Redman, T., & Maguire, S. (2013). Green human resource management: A review and research agenda. *International Journal of Management Reviews*, *15*(1), 1–14. https://doi.org/10.1111/j.1468-2370.2011.00328.x

Rosenbusch, N., Brinckmann, J., & Bausch, A. (2011). Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. *Journal of Business Venturing*, *26*(4), 441–457. https://doi.org/10.1016/j.jbusvent.2009.12.002

Rosenthal, R., & DiMatteo, M. R. (2001). Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Review of Psychology*, *52*(1), 59–82. https://doi.org/10.1146/annurev.psych.52.1.59

Saputro, A., & Nawangsari, L. C. (2021). The effect of green human resource management on organization citizenship behaviour for environment (OCBE) and its implications on employee performance at Pt Andalan Bakti Niaga. *European Journal of Business and Management Research*, *6*(1), 174–181. https://doi.org/10.24018/ejbmr.2021.6.1.716

Setyaningrum, R. P., & Muafi, M. (2023). Green human resources management on business performance: The mediating role of green product innovation and environmental commitment. *International Journal of Sustainable Development and Planning*, *18*(1), 209–220. https://doi.org/10.18280/ijsdp.180122

Sezen, B., & Çankaya, S. Y. (2013). Effects of green manufacturing and eco-innovation on sustainability performance. *Procedia - Social and Behavioral Sciences*, *99*, 154–163. https://doi.org/10.1016/j.sbspro.2013.10.481

Shafiq, M. A., Ramzan, M., Faisal, M. M., & Iqbal, S. (2023). Exploring the relationship between green human resource management and green creativity: The moderating influence of green behavioral intention. *Pakistan Journal of Humanities and Social Sciences*, *11*(1), 426–439. https://doi.org/10.52131/pjhss.2023.1101.0362

Sobaih, A. E. E., Hasanein, A., & Elshaer, I. (2020). Influences of green human resources management on environmental performance in small lodging enterprises: The role of green innovation. *Sustainability*, *12*(24), 10371. https://doi.org/10.3390/su122410371

Song, D., Bai, Y., Wu, H., & Wang, X. (2022). How does the perceived green human resource management impact employee's green innovative behavior?—From the perspective of theory of planned behavior. *Frontiers in Psychology*, *13*, 1106494. https://doi.org/10.3389/fpsyg.2022.1106494

Ta'Amnha, M. A., Al-Qudah, S., Asad, M., Magableh, I. K., & Riyadh, H. A. (2024). Moderating role of technological turbulence between green product innovation, green process innovation and performance of SMEs. *Discover Sustainability*, *5*(1). https://doi.org/10.1007/s43621-024-00522-w

Tantayanubutr, M., & Panjakajornsak, V. (2017). Impact of green innovation on the sustainable performance of thai food industry. *Business and Economic Horizons*, *13*(2), 192–209. https://doi.org/10.15208/beh.2017.15

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Tipton, E. (2015). Small sample adjustments for robust variance estimation with meta-regression. *Psychological Methods*, *20*(3), 375–393. https://doi.org/10.1037/met0000011

Tran, N. K. H. (2023). An empirical investigation on the impact of green human resources management and green leadership on green work engagement. *Heliyon*, *9*(11), e21018. https://doi.org/10.1016/j.heliyon.2023.e21018

Úbeda-García, M., Marco-Lajara, B., Zaragoza-Sáez, P. C., Manresa-Marhuenda, E., & Poveda-Pareja, E. (2022). Green ambidexterity and environmental performance: The role of green human resources. *Corporate Social Responsibility and Environmental Management*, *29*(1), 32–45. https://doi.org/10.1002/csr.2171

Ullah, S., Ahmad, T., Kukreti, M., Sami, A., & Shaukat, M. R. (2024). How organizational readiness for green innovation, green innovation performance and knowledge integration affects sustainability performance of exporting firms. *Journal of Asia Business Studies*, *18*(2), 519–537. https://doi.org/10.1108/JABS-02-2023-0056

Veerasamy, U., Joseph, M. S., & Parayitam, S. (2024). Green human resource management practices and employee green behavior. *Journal of Environmental Planning and Management*, *67*(12), 2810–2836. https://doi.org/10.1080/09640568.2023.2205005

Wagner, M. (2010). The role of corporate sustainability performance for economic performance: A firm-level analysis of moderation effects. *Ecological Economics*, *69*(7), 1553–1560. https://doi.org/10.1016/j.ecolecon.2010.02.017

Weng, H. H. R., Chen, J. S., & Chen, P. C. (2015). Effects of green innovation on environmental and corporate performance: A stakeholder perspective. *Sustainability (Switzerland)*, *7*(5), 4997–5026. https://doi.org/10.3390/su7054997

Xie, X., Huo, J., & Zou, H. (2019). Green process innovation, green product innovation, and corporate financial performance: A content analysis method. *Journal of Business Research*, *101*, 697–706. https://doi.org/10.1016/j.jbusres.2019.01.010

Yang, M., & Li, Z. (2023). The influence of green human resource management on employees' green innovation behavior: The role of green organizational commitment and knowledge sharing. *Heliyon*, *9*(11), e22161. https://doi.org/10.1016/j.heliyon.2023.e22161

Yildiz Çankaya, S., & Sezen, B. (2019). Effects of green supply chain management practices on sustainability performance. *Journal of Manufacturing Technology Management*, *30*(1), 98–121. https://doi.org/10.1108/JMTM-03-2018-0099

Yurdakul, M., & Kazan, H. (2020). Effects of eco-innovation on economic and environmental performance: Evidence from Turkey's manufacturing companies. *Sustainability*, *12*(8), 3167. https://doi.org/10.3390/su12083167

Zhang, D., Rong, Z., & Ji, Q. (2019). Green innovation and firm performance: Evidence from listed companies in China. *Resources, Conservation and Recycling*, *144*, 48–55. https://doi.org/10.1016/j.resconrec.2019.01.023

Zhang, J. A., & Walton, S. (2017). Eco-innovation and business performance: The moderating effects of environmental orientation and resource commitment in green-oriented SMEs. *R&D Management*, *47*(5), E26–E39. https://doi.org/10.1111/radm.12241

Zhang, W., Zhang, W., & Daim, T. U. (2023). The voluntary green behavior in green technology innovation: The dual effects of green human resource management system and leader green traits. *Journal of Business Research*, *165*, 114049. https://doi.org/10.1016/j.jbusres.2023.114049

Zhu, Y., & Jin, S. (2023). How does the digital transformation of banks improve efficiency and environmental, social, and governance performance? *Systems*, *11*(7), 328. https://doi.org/10.3390/systems11070328

Zihan, W., & Makhbul, Z. K. M. (2024). Green human resource management as a catalyst for sustainable performance: Unveiling the role of green innovations. *Sustainability*, *16*(4), 1453. https://doi.org/10.3390/su16041453

Zulkiffli, S. N., 'Atikah, Zaidi, N. F. Z., Padlee, S. F., & Sukri, N. K. A. (2022). Eco-innovation capabilities and sustainable business performance during the COVID-19 pandemic. *Sustainability*, *14*(13), 7525. https://doi.org/10.3390/su14137525