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ORIGINAL CONTRIBUTION

Co-Creating Sustainable Innovation From Within: Green HRM Practices Enabling Employee Green Behavior in KIBS Ecosystems Across Pakistan, China, And Uzbekistan

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Abstract— Knowledge-Intensive Business Service (KIBS) firms depend on employees who translate specialized knowledge into client-facing and ecosystem-level innovation, yet the human-resource mechanisms that support environmentally oriented behavior in these firms remain underexamined across heterogeneous Asian contexts. This study examines whether three Green Human Resource Management (GHRM) practices eco-skill-focused recruitment, digitally integrated green training, and community-impact-oriented green rewards are associated with Employee Green Behavior (EGB), whether EGB is associated with Environmental Innovation Performance (EIP), and whether these relationships differ across Pakistan, China, and Uzbekistan. The study retained 1,256 usable questionnaire records from 412 participating firms and reports the pooled PLS-SEM analysis using the original sample size of n = 1,256. A multi-respondent design separated the principal information sources, with HR representatives reporting GHRM practices and non-HR employees reporting EGB and EIP. Green recruitment (β = .24), digital green training (β = .32), and community-impact rewards (β = .28) were positively associated with EGB, while EGB was strongly associated with EIP (β = .62; all p < .001). The model accounted for 58% of the variance in EGB and 64% in EIP. All three GHRM–EIP pathways had significant indirect effects through EGB (indirect β = .15–.20, VAF=48%–56%). The direction of the country coefficients was consistent with the proposed contextual pattern: digital training had the highest beta in China (β =.38), community-impact rewards had the highest beta in Pakistan (β = .34), and the beta for the EGB–EIP relationship was the highest in China (β = .66). The omnibus permutation-based MGA showed evidence of cross-country heterogeneity (p < .01); however, no significance was claimed for individual pairwise comparisons as those permutation p-values were not reported in the results. The study provides a theoretical interpretation of the measured construct of EGB as a boundary-spanning behavioral interface that enables internal employees to interact with and contribute to externally co-created environmental innovation, rather than as a separately validated scale. The findings build on AMO reasoning by revealing the relative salience of the ability, motivation, and opportunity mechanisms in KIBS ecosystems across countries.

Index Terms— Green human resource management, Employee green behavior, Environmental innovation performance, Knowledge-intensive business services, AMO theory, Value co-creation, Pakistan, China, Uzbekistan

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Introduction

Knowledge-Intensive Business Services (KIBS), including information technology, software development, and management consulting, create value through specialized knowledge, intensive interaction, and collaborative problem-solving. Their innovation processes therefore depend heavily on employees who operate across internal organizational routines and client or ecosystem relationships. Recent KIBS research emphasizes that innovation in knowledge-intensive services is shaped by the firm's knowledge base, human capital, and collaborative structures (Krupskaya, 2025). At the same time, digital-green value co-creation research shows that environmental innovation increasingly depends on integrating knowledge and resources across organizational boundaries (Yin & Zhao, 2024). These characteristics make KIBS a useful setting for examining how internal people-management systems can support sustainable innovation beyond mere compliance.

Green Human Resource Management (GHRM) provides one such internal system. GHRM embeds environmental criteria in recruitment, training, performance management, rewards, and employee involvement. A substantial body of evidence now links GHRM with green psychological climates, pro-environmental behavior, green innovation, and environmental performance (Aftab et al., 2023; Al-Swidi et al., 2021; Rubel et al., 2021; Sabokro et al., 2021; Zafar & Suseno, 2024). Recent conceptual work also cautions against treating GHRM as a standardized checklist: AMO-aligned practices can operate through different cultural and contextual configurations (Maheshwari et al., 2024; Mukherji & Bhatnagar, 2022). However, the literature remains fragmented in three ways. First, much of the evidence comes from manufacturing, hospitality, higher education, and other settings where environmental outcomes are easier to tie to physical operations. KIBS rely more heavily on knowledge sharing, client interaction, and intangible service innovation, so the behavioral route from HR practices to environmental innovation may operate differently. Second, recent research shows that employee green behavior does not occur automatically because of GHRM; intervening climates, identities, knowledge, self-efficacy, and leadership conditions influence employee green behavior (Miah et al., 2024; Tandon et al., 2023). Third, cross-national evidence is still very limited, despite the potential for the impact of specific HR practices to be influenced by national digital infrastructure, environmental policy and social expectations (Ali et al., 2025).

These three countries were selected because they represent theoretically meaningful institutional contrasts rather than interchangeable emerging-market contexts. The combination of advanced digital infrastructure and a policy push for green transformation should help to make digitally mediated training and knowledge sharing more useful in China. Pakistan has a fast-digitalising service economy, however environmental pressures are pronounced, and community-oriented expectations are high and thus, visible and socially meaningful rewards have the potential to be salient. Uzbekistan is a transitional country where digital modernization and institutional changes are underway, but not well developed and widely spread throughout the country. These contexts enable a comparison to test whether the same general GHRM–behaviour–innovation process is triggered by the use of different dominant HR levers.

This study therefore aims to investigate the relationship between digitally and community-integrated GHRM practices and EGB and EIP in KIBS and the extent of these relationships in the three countries. How eco-skill recruitment enhances ability, community-impact rewards enhance motivation, and digitally integrated green training enhances opportunities to gain and share green knowledge is explained using the Ability–Motivation–Opportunity (AMO) framework. In addition to the AMO perspective, we apply a value co-creation perspective that underscores that employees in KIBS are typically those who interpret their internal capacities in the solutions they create with clients and other external actors. It is important to note that the 'Ecosystem-Enabled Green Behavior' in this study is not measured as an independent construct. Rather, boundary-spanning EGB is presented as a theoretical interpretation of the empirical EGB dimensions (eco-initiatives, eco-civic engagement, and eco-helping) and of the role that boundary-spanning EGB can play in fostering environmental innovation in a service ecosystem.

Three bounded contributions emerge from the study. First, it extends employee-level GHRM research by moving beyond treating GHRM as an undifferentiated bundle and examining differentiated recruitment, training, and reward practices in KIBS. Second, it connects these practices to EIP via EGB, which offers behavioral evidence for the internal-to-external pathway suggested by AMO and co-creation reasoning. Third, it investigates the difference in the relative salience of opportunity- and motivation-oriented GHRM practices across Pakistan, China, and Uzbekistan through the lens of measurement-invariance assessment and multi-group comparison. These contributions are not intended to propose a new behavioral construct but rather to extend previous research in the fields of GHRM and co-creation.

Research question

RQ: How are differentiated GHRM practices associated with employee green behavior and environmental innovation performance in KIBS firms, and how do these relationships differ across Pakistan, China, and Uzbekistan?

Research objectives

- To examine the associations of eco-skill-focused green recruitment, digitally integrated green training, and community-impact-oriented green rewards with employee green behavior in KIBS firms.
- To test the association between employee green behavior and environmental innovation performance.
- To assess whether employee green behavior mediates the relationships between the three GHRM practices and environmental innovation performance.

- To compare the focal structural relationships across Pakistan, China, and Uzbekistan after establishing measurement invariance.

Literature Review and Theoretical Foundation

KIBS ecosystems, sustainable innovation, and co-creation

KIBS firms create and recombine knowledge for clients, making employees central actors in innovation. The results they deliver are often not physical products, but software, analytics, digital solutions, and/or new practices, and methodologies, meaning environmental innovation can potentially be developed in other ways besides physical product redesign. This makes employee initiative and knowledge exchange especially important. Recent work on service innovation in knowledge-intensive services emphasizes the role of knowledge bases and professional interaction in shaping innovation trajectories (Krupskaya, 2025), while research on digital green value co-creation shows that collaborative network embedding can enhance green innovation performance (Yin & Zhao, 2024).

A value co-creation perspective is therefore useful because environmental value in KIBS can be produced jointly by employees, clients, partners, and communities (Vargo & Lusch, 2016). Yet co-creation theory says relatively little about how employees acquire the competencies, motivation, and organizational opportunities required to participate effectively. GHRM offers a plausible internal antecedent. The theoretical problem is not whether HR practices directly 'create' ecosystem innovation, but how internal HR systems can enable employee behaviors that later contribute to knowledge sharing, process improvement, client problem solving, and environmentally oriented service innovation.

Green HRM as an AMO system

AMO theory proposes that employee performance is strongest when people possess relevant abilities, are motivated to act, and have opportunities to participate. GHRM maps naturally onto this logic. Green recruitment and selection can build an ability base by attracting employees with environmental knowledge and values. Green training can create both ability and opportunity by improving knowledge while providing spaces in which employees exchange ideas. Reward and recognition systems can reinforce motivation, by making employees 'environmental contributions visible and valued. This systems view aligns with the earlier theorization of GHRM as a system of fundamental practices (Renwick et al., 2013) and more recent theorisation which views GHRM as an AMO-configured architecture rather than a checklist (Mukherji & Bhatnagar, 2022). Empirical studies further validate that GHRM is a system and that different practices can have different behavioral impacts (Al-Swidi et al., 2021; Hooi et al., 2022; Maheshwari et al., 2024; Muisyo et al., 2022; Shah & Soomro, 2023).

This is a differentiated perspective, especially relevant for KIBS. Digital training is not just about online classroom training, but can also link geographically dispersed employees, clients and experts in knowledge-intensive services. Community-impact rewards are also no longer just for doing the green thing, when the reward is based on an outcome that employees can see in their clients or their community. Rather than being new types of HRM, the argument here is that the digital and community focus of these practices could alter the way we understand how GHRM mechanisms operate in service ecosystems.

Employee green behavior and environmental innovation performance

Employee Green Behavior (EGB) includes discretionary and role-related actions through which employees conserve resources, propose environmental improvements, support colleagues, and participate in organizational environmental initiatives. The organizational citizenship behavior for the environment literature emphasizes eco-initiatives, eco-civic engagement, and eco-helping as related but distinct forms of behavior (Bano et al., 2025; Boiral & Paillé, 2012). More recent evidence shows that GHRM can shape such behavior through green work climates, psychological processes, knowledge, and organizational pride (Miah et al., 2024; Rubel et al., 2021; Sabokro et al., 2021; Wallter, 2021; Zafar & Suseno, 2024).

Environmental Innovation Performance (EIP) refers here to the extent to which firms improve processes and develop products or services that reduce environmental impact. In KIBS, EIP may involve energy-efficient digital workflows, low-carbon advisory services, redesigned service-delivery processes, or digital substitutes for resource-intensive activities. GHRM may influence EIP directly through systems and indirectly through employee behavior. The growing body of research has found that green innovation and employee green behavior are significant links between GHRM and environmental and sustainability performance (Aftab et al., 2023; Ali et al., 2024).

Integrating AMO and value co-creation: EGB as a boundary-spanning interface

In terms of capability, motivation and participation of employees, AMO is good at explaining how these things are produced within the organization, but its traditional use typically focuses on the intra-organizational level of performance. In contrast to value co-creation, actors' ability and willingness to act as value co-creators is not explicitly defined. The two views taken together imply a sequential logic: GHRM creates internal ability, motivation, and opportunity; employees apply internal A, M, O in EGB; and in some cases in KIBS, some of the behaviors in EGB become part of client and ecosystem problem-solving processes that feed into EIP.

We'll call this a 'boundary-spanning interpretation of EGB'. This is not a new latent variable, but rather a "theoretical lens" that is intentionally offered. The empirical model measures the already known dimensions of EGB and assesses the relationship between EGB and EIP. The co-creation contribution is in offering an explanation about why the same behaviors of employees can be significant beyond conserving internal resources when employees are not conserving the resources.

Cross-national context

The importance of cross-national comparison is that the AMO mechanisms are shaped by the opportunity structure in the context in which they operate, as well as by what employees consider to be meaningful motivation. China has relatively good digital and policy infrastructure for green transformation, which can be transformed into collaborative learning and knowledge utilization more easily through digital training. Pakistan's service firms are operating under pronounced environmental pressures, where environmental salience is high, and community-related recognition may serve as a potential motivator. Digital and institutional modernization is more significant and likely to have a positive impact in Uzbekistan, while organizational systems are more transitional, which means that effects are likely to be positive but generally weaker.

The general thesis that the national and institutional context can influence the strength of GHRM relationships is supported by more recent evidence. As an illustration, in China and Pakistan, there is significant cross-country variation in green innovative behavior related to GHRM (Khan et al., 2025). To avoid making the assumption of uniform effects, this study therefore takes a theoretical approach to country as a grouping variable and applies a MICOM (before MGA) procedure to avoid confounding observed differences with measurement non-equivalent.

Hypothesis development

GHRM practices and employee green behavior

The change in EGB should be positively associated with eco-skill-focused recruitment, as this would boost the likelihood that an employee joins the organization with a knowledge, value and problem-solving ability regarding the environment. Green recruitment is also a sign of environmental contribution as a part of the employment relationship. Based on the empirical research, it is found that GHRM dimensions of recruitment, training, performance, and reward are correlated with both task-related and voluntary green behaviors (Shah & Soomro, 2023).

H1a: Eco-skill-focused green recruitment is positively associated with employee green behavior.

There should be a positive correlation between digitally integrated green training and EGB as it could be used to strengthen knowledge and also opportunities to share and apply it. Digital training can be used in KIBS to enhance cross-functional and client-oriented learning, not just individual skills. This is supported by the evidence that there is a link between green training, psychological climate and voluntary green behavior (Amrutha & Geetha, 2021; Zafar & Suseno, 2024).

H1b: Digitally integrated green training is positively associated with employee green behavior.

Green rewards that have a community impact should reinforce EGB by making the social outcomes of environmental action apparent and rewarding behavior with a "social dividend" beyond the employee's job function. Reward systems are particularly important when workers perceive environmental contribution as a social good and not just compliance. Rewards and recognition are widely regarded as motivational elements of green behavior systems in previous studies of GHRM (Al-Swidi et al., 2021; Tandon et al., 2023).

H1c: Community-impact-oriented green rewards are positively associated with employee green behavior.

Employee green behavior and environmental innovation performance

EGB provides the micro-behavioral inputs from which environmental innovation can emerge. Eco-initiatives generate ideas, eco-helping diffuses knowledge, and eco-civic engagement connects employees with collective environmental programs. In KIBS, these behaviors can influence process redesign and client solutions because innovation depends on the recombination of employee knowledge. This reasoning is consistent with evidence linking green behavior, green innovation, and environmental performance (Aftab et al., 2023; Ali et al., 2024).

H2: Employee green behavior is positively associated with environmental innovation performance.

Mediating role of employee green behavior

GHRM creates conditions for environmentally responsible action, but HR practices do not automatically become innovation outcomes. Employees must enact the competencies, motivation, and opportunities generated by HR systems. EGB is therefore expected to mediate each GHRM–EIP relationship. Because the distinction between partial and full mediation depends on the joint pattern of the indirect effect and the corresponding direct effect, the hypotheses do not prespecify the type of mediation. The empirical test focuses on bootstrapped indirect effects; VAF is reported as a descriptive share of the total association rather than used by itself to classify mediation.

H3a: Employee green behavior mediates the relationship between eco-skill-focused green recruitment and environmental innovation performance.

H3b: Employee green behavior mediates the relationship between digitally integrated green training and environmental innovation performance.

H3c: Employee green behavior mediates the relationship between community-impact-oriented green rewards and environmental innovation performance.

Directional expectations across national contexts

There are contextual differences between the three countries that can affect the effectiveness of certain AMO levers. A more solid foundation of digital infrastructure in China will drive the return to digitally integrated training, as the opportunity structures of employees to transform e-learning and digital knowledge exchange into work behavior will be stronger. The motivational relevance of community-impact rewards should be enhanced by community salience and immediate environmental stressors in Pakistan. Last but not least, the EGB–EIP path is expected to be strongest in the case of green policy and digital innovation systems, where there is a greater degree of complementarity between organizational resources, and we predict that this will be the case in China. They are more specific than a generalised 'relationships vary' prediction, and are directly related to the MGA reported below.

H4a: The positive relationship between digitally integrated green training and employee green behavior is stronger in China than in Pakistan and Uzbekistan.

H4b: The positive relationship between community-impact-oriented green rewards and employee green behavior is stronger in Pakistan than in China and Uzbekistan.

H4c: The positive relationship between employee green behavior and environmental innovation performance is stronger in China than in Pakistan and Uzbekistan.

Conceptual framework

Figure 1 summarizes the model. The three GHRM practices represent differentiated ability, opportunity, and motivation levers; EGB is the mediating behavioral mechanism; EIP is the outcome; and national context is examined through multi-group comparison. The boundary-spanning interpretation explains how EGB can connect internal HR systems with client- and ecosystem-facing environmental innovation without treating boundary-spanning behavior as an independently measured construct.

GHRM practices	Behavioral mechanism	Outcome
Eco-skill recruitment (Ability) Digital green training (Opportunity) Community-impact rewards (Motivation)	Employee green behavior Eco-initiatives • Eco-civic engagement • Eco-helping	Environmental innovation performance Green process innovation • Green product/service innovation

National context (Pakistan, China, and Uzbekistan) is assessed through MICOM-supported multi-group analysis of the focal structural paths.

Fig. 1 *Conceptual framework*

Methodology

Research design, sampling, and data collection

The study used a quantitative, cross-sectional, cross-national survey design. The sample included employees from medium-to-large KIBS firms (50+ employees) in IT services, software development, and management consulting in Pakistan, China, and Uzbekistan. The three countries have been chosen not for their statistical representativeness of Asia, but to provide a theoretically meaningful institutional contrast: China is a digitally mature country; Pakistan, an emerging-service context under environmental stress; and Uzbekistan, a transitional context with digital and institutional reform underway. This rationale mirrors the country-contingency argument developed in literature and methodology. Publicly available professional and business directories—including PASHA-related listings in Pakistan, software-industry listings in China, and IT Park-related listings in Uzbekistan—were used to identify eligible firms. The sampling plan sought variation in firm size, ownership, and KIBS sub-sector so that the country samples were not dominated by one organizational type.

Treatment of nested data structure

Given that employee-level observations (n = 1,256) were nested within firms (n = 412, average 3.05 employees per firm), the potential influence of firm-level clustering was assessed before selecting the analytical approach. Consistent with the theoretical framing of Employee Green Behavior

(EGB) and Environmental Innovation Performance (EIP) as employee-level perceptual and behavioral outcomes, employees were treated as the unit of analysis.

Variance components were examined using a one-way random-effects ANOVA with firm identification as the grouping variable. The between-firm variance and within-firm variance were 0.031 and 0.486 for EGB, respectively, and 0.028 and 0.452 for EIP, respectively. ICC1 values were 0.060 for EGB and 0.058 for EIP, indicating limited between-firm variance.

ICC2 values calculated using the average group size (k = 3.05) were 0.163 for EGB and 0.158 for EIP. These values indicate that firm-level means did not reach sufficient reliability for aggregation. Within-group agreement rwg(j), calculated from item-level responses using the uniform null distribution approach, was 0.81 for EGB and 0.80 for EIP, showing acceptable agreement among respondents within firms. However, agreement alone does not establish that aggregation is appropriate because ICC2 determines the reliability of group means.

The design effects were 1.123 for EGB and 1.119 for EIP, both below commonly used thresholds indicating the need for multilevel correction. Based on the combined evidence of low ICC1 values, limited ICC2 reliability, acceptable within-group agreement, and small design effects, firm-level aggregation and multilevel correction were not considered necessary for the present employee-level analysis.

A pilot test involved 90 respondents (30 per country). Participants assessed clarity, relevance, and questionnaire length; the overall clarity score was 4.38/5 and the mean completion time was 11.8 minutes. Minor wording clarifications were made to three items to improve the clarity of digital integration. To achieve linguistic equivalence, Urdu, Mandarin Chinese, and Uzbek/Russian versions were prepared by back-translation procedures.

Following the screening of incomplete and/or outlier responses, 1,256 usable questionnaire responses were obtained: Pakistan n = 412, China n = 428, and Uzbekistan n = 416. These are the country sample sizes provided in the analysis submitted and total to the n = 1256 for the country structural summaries and MGA reporting. There were 412 firms that participated, contributing to the 1,256 questionnaire records used in the analysis. Of the 3,456 firms approached, 412 firms participated, resulting in an approximate 12% firm-level response rate. The proportion of respondents to the employee-level questionnaires ranged from about 32% to 38% across the participating organizations. There were no significant differences between early and late responses for the focal variables. The manuscript presents the pooled structural analysis of the 1,256 cases that were documented in the submitted results and separates this analytical sample from the 412 organizational clusters. The relatively low firm-level participation rate and residual dependence among records from the same firm are treated explicitly as limitations rather than as evidence of representativeness or statistical independence.

Ethical approval: The study protocol was approved by the Ajou University Tashkent Ethics Committee (Approval Reference No. AUT-2026-197, dated 15th April, 2026) in Tashkent, Uzbekistan. The research was carried out in accordance with the Guidelines and Regulations of this Ethics Committee and the ethical principles of the Declaration of Helsinki. All procedures were performed in accordance with the relevant guidelines and regulations. The study was conducted with informed consent, and all participants were asked to voluntarily participate in the study; informed consent was obtained by all participants before data collection; all data were gathered and analyzed anonymously and treated confidentially.

Measures

All constructs were measured using a five-point Likert scale (1=strongly disagree, 5=strongly agree) and were adapted from established measures. Green recruitment with eco-skill focus was measured with three items based on Tang et al. (2018). Digitally integrated green training used four items informed by Tang et al. (2018) and Teixeira et al. (2016). Community-impact-oriented green rewards used three items adapted from the green reward domain of Tang et al. (2018), with wording contextualized to community and ecosystem outcomes.

EGB was specified as a higher-order reflective construct comprising eco-initiatives, eco-civic engagement, and eco-helping, adapted from Boiral and Paillé (2012). EIP was specified as a higher-order construct combining green process innovation and green product/service innovation. The 'boundary-spanning' terminology is not an additional measure; it is used only to interpret how the established EGB dimensions may carry internal GHRM effects into KIBS innovation processes.

Analytical strategy

PLS-SEM was selected because the model combines higher-order constructs, a formative EIP specification, multiple indirect effects, and cross-country group comparison, with an emphasis on explaining variance and comparing structural paths. These features make variance-based SEM suitable for the study's explanatory-predictive and comparative purpose, particularly with higher-order/formative specifications and group comparisons (Hair et al., 2019; Sarstedt et al., 2022). The choice does not mean that PLS-SEM is superior to covariance-based SEM for all models and research purposes, but simply that the choice is consistent with the current model and the current research goal.

The analysis was conducted in five steps. The first evaluation was conducted on the measurement model by assessing indicator loadings, Cronbach's alpha, composite reliability, Average Variance Extracted (AVE), Fornell–Larcker comparisons, and HTMT ratios. In addition, the three-step procedure for implementing MICOM (configural invariance, compositional invariance, and assessment of equality of composite means and variances) was completed prior to cross-country comparison (Henseler et al., 2016). Third, bootstrapping with 5,000 resamples, R^2, and f^2 were used for the evaluation of structural paths. Fourth, indirect effects were examined by bootstrapping and Variance Accounted For (VAF)

(Zhao et al., 2010), which was not used as a criterion to classify the mediation as partial or full. Fifth, the focus on structural relationships was examined for differences across the three countries using a permutation-based MGA. In the cases of H4a–H4c, the inferential evidence for heterogeneity comes from the permutation-based cross-group test, and the pre-specified directional expectations are compared with the observed ordering of the coefficients. No pairwise p-values were saved or reported in the manuscript, so no pairwise significance is claimed that is not clearly documented. The robustness diagnostics consisted of a Harman single-factor diagnostic, a marker-variable check, VIFs, a Gaussian-copula endogeneity diagnostic, and early/late response comparison. In keeping with common-method-bias advice (Podsakoff et al., 2003), Harman's test is not treated as a definitive indicator of the lack of common-method bias.

Results

Measurement model

The measurement model demonstrated acceptable reliability and convergent validity. Cronbach's alpha ranged from .87 to .93, composite reliability from .91 to .95, and AVE from .72 to .78. Indicator loadings were above .70. The formative weights for the EIP dimensions were significant and multicollinearity was not problematic (VIFs below 2.3). Fornell–Larcker comparisons and HTMT ratios supported discriminant validity; the largest HTMT ratio was .78. MICOM established configural and compositional invariance across the three country groups. In the retained MICOM output, compositional c-values exceeded .95, and the comparisons of composite means and variances were non-significant. Taken together, these results support sufficient measurement invariance for the reported cross-country MGA and support interpretation of the pooled structural pattern.

Table I
Measurement model results

Construct / dimension	Items	Loading range	Cronbach α	CR	AVE
Green recruitment (eco-skill focus)	3	.82–.88	.89	.93	.72
Green training (digital integration)	4	.79–.91	.92	.94	.78
Green rewards (community impact)	3	.84–.89	.88	.92	.75
EGB – eco-initiatives	3	.81–.88	.87	.91	.72
EGB – eco-civic engagement	4	.82–.89	.90	.93	.74
EGB – eco-helping	3	.83–.88	.89	.92	.73
EIP – green process innovation	6	.80–.89	.93	.95	.76
EIP – green product/service innovation	6	.81–.88	.91	.93	.74

All reported loadings were significant at p <.001.

Table II
Fornell–Larcker criterion

Construct	1	2	3	4	5
1. Green recruitment	.85				
2. Green training	.62	.88			
3. Green rewards	.58	.65	.87		
4. EGB	.55	.68	.61	.86	
5. EIP	.48	.59	.54	.72	.87

Diagonal entries are the square roots of AVE

Table III
HTMT ratios

Construct	1	2	3	4	5
1. Green recruitment	–				
2. Green training	.68	–			
3. Green rewards	.64	.71	–		
4. EGB	.61	.74	.67	–	
5. EIP	.53	.65	.59	.78	–

All HTMT ratios are below .85.

Structural model and hypothesis tests

All four focal direct paths were positive and statistically significant. Green recruitment was associated with EGB (β = .24, p < .001), digital green training showed the strongest GHRM-dimension effect on EGB (β = .32, p <.001), and community-impact rewards were also positively associated

with EGB (β = .28, p < .001). EGB had a strong positive relationship with EIP (β = .62, p < .001). The model explained 58% of the variance in EGB and 64% of the variance in EIP. The relative f^2 values show that digital training (.27) contributes more incremental explanatory power than recruitment (.18) or rewards (.22), while EGB→EIP (.35) is the largest structural effect. Thus, the substantive pattern is not limited to statistical significance.

Table IV
Structural path results

Path	β	T	p	f^2	Decision
H1a: Green recruitment → EGB	.24	6.11	<.001	.18	Supported
H1b: Digital green training → EGB	.32	8.56	<.001	.27	Supported
H1c: Community-impact rewards → EGB	.28	7.14	<.001	.22	Supported
H2: EGB → EIP	.62	15.39	<.001	.35	Supported

R^2(EGB)=.58; R^2(EIP)=.64. Significance based on 5,000 bootstrap resamples

Mediation

Bootstrapped indirect effects were positive and statistically significant for all three GHRM practices. The indirect effect was .15 for green recruitment, .20 for digital green training, and .17 for community-impact rewards (all p < .001). VAF values ranged from 48% to 56%, showing that a substantial share of each total association operated through EGB. Because the corresponding direct GHRM-dimension→EIP effects are not separately reported in the retained structural summary, VAF is not used by itself to label the mediation as partial or full. H3a–H3c are therefore supported as mediation hypotheses on the basis of the significant bootstrapped indirect effects.

Table V
Mediation results

Indirect path	β indirect	T	p	VAF	Interpretation
Green recruitment → EGB → EIP	.15	5.38	<.001	48%	Significant indirect effect
Digital green training → EGB → EIP	.20	7.08	<.001	56%	Significant indirect effect
Community-impact rewards → EGB → EIP	.17	6.03	<.001	52%	Significant indirect effect

Bootstrapping=5,000 resamples. VAF is reported descriptively and is not used alone to classify mediation as partial or full

Multi-group analysis

The permutation-based MGA indicated cross-country heterogeneity across the focal structural relationships (p < .01), and the observed coefficient ordering was directionally consistent with the three pre-specified contextual expectations. For H4a, digital green training had its largest association with EGB in China (β = .38), compared with Pakistan (β = .28) and Uzbekistan (β = .26), giving descriptive contrasts of $\Delta\beta$ = .10 and $\Delta\beta$ = .12, respectively. For H4b, community-impact rewards were strongest in Pakistan (β = .34), compared with China (β = .29) and Uzbekistan (β = .25), with contrasts of $\Delta\beta$ = .05 and $\Delta\beta$ =.09. For H4c, the EGB–EIP relationship was strongest in China (β=.66), compared with Pakistan (β =.61) and Uzbekistan (β =.58), with contrasts of $\Delta\beta$ = .05 and $\Delta\beta$ = .08. Green recruitment was strongest in Pakistan (β = .27) but remains an exploratory country pattern because no directional hypothesis was specified for that path. Because individual pairwise permutation p-values were not retained in the reported output, H4a–H4c are interpreted as directionally supported at the pattern level conditional on the permutation-based evidence of cross-country heterogeneity; the manuscript does not claim that every pairwise contrast is individually significant.

Table VI
Multi-group analysis

Path	Pakistan β	China β	Uzbekistan β	Strongest context
Green recruitment → EGB	.27	.23	.21	Pakistan
Digital green training → EGB	.28	.38	.26	China
Community-impact rewards → EGB	.34	.29	.25	Pakistan
EGB → EIP	.61	.66	.58	China

MICOM was established before MGA using configural/compositional invariance and the retained mean/variance checks. The permutation-based MGA indicated cross-country heterogeneity in the focal relationships at p < .01. Descriptive pairwise $\Delta\beta$ values are reported in the text; individual pairwise permutation p - values are not claimed because they were not retained in the reported output.

Robustness diagnostics

Robustness diagnostics provided complementary checks on potential bias. Harman's single-factor diagnostic showed that the first factor accounted for 32.4% of the variance. The marker-variable correlation was small and non-significant (r = .08), VIFs ranged from 1.2 to 2.3, and Gaussian-copula

diagnostics were non-significant (p = .12–.23). Early-versus-late response comparisons were also non-significant. Taken together with source separation in the survey design, these diagnostics reduce but do not eliminate the possibility that common-method variance, multicollinearity, endogeneity, or non-response bias explains the reported relationships.

Table VII
Robustness diagnostics

Diagnostic	Reported statistic	Interpretation
Harman single-factor diagnostic	32.4%	Below 50%; limited evidence against a dominant common factor
Marker variable	r=.08, ns	Small, non-significant association
VIF	1.2–2.3	No problematic multicollinearity
Gaussian copula	p=.12–.23	No significant endogeneity signal
Early/late response comparison	Δ<.05, ns	No significant wave difference

These tests are interpreted as complementary diagnostics rather than definitive proof of the absence of bias.

Discussion

The results show that all three differentiated GHRM practices are associated with stronger EGB, but the size and cross-national pattern of these relationships are not uniform. Digital green training emerged as the strongest GHRM predictor in the pooled model and was particularly strong in China. This pattern is theoretically meaningful because training in KIBS does more than transfer individual knowledge; digitally integrated training can also expand the opportunity structure through which employees exchange green knowledge and apply it in collaborative problem solving. It is in line with the findings of recent studies showing that employee responses to GHRM are influenced by contextual resources and organizational mechanisms, as opposed to merely the fact that the organization has green policies (Miah et al., 2024; Rubel et al., 2021; Tandon et al., 2023). The model accounts for 58% of the variance in EGB and 64% of the variance in EIP from a practical significance standpoint, with the digital-training effect accounting for more variance than recruitment (58% of the variance in EIP) and rewards (64% of the variance in EIP). The findings therefore demonstrate both statistical significance and practical relevance.

The highest community impact rewards effect was observed in Pakistan. The results indicate that the motivational aspect of AMO can be particularly powerful when environmental performance is presented in terms of socially visible outcomes. The pattern reflects neither a greater collectivism among Pakistani employees nor the irrelevance of rewards in other settings but rather suggests a higher degree of behavioral salience of such a reward system when it involves outcomes in the external environment and/or in the community. The smaller correlation coefficient in Uzbekistan also suggests caution in transferring of the same reward system to the transition context.

EGB had a strong positive relationship with EIP in all three countries, especially in China. This outcome is consistent with the core behavioral premise of the model: HR systems are important for innovation because they are manifested through environmental actions, civic involvement, and helping behaviors. The connection between EGB and EIP is similar to the research that explores the relationship between employee behavior and green innovation and further sustainability performance (Aftab et al., 2023; Ali et al., 2024). Meanwhile, the substantial indirect effects do not mean that there is only one path that connects GHRM to innovation. Previous research (Aggarwal & Agarwala, 2023; Al-Swidi et al., 2021; Zafar & Suseno, 2024) indicates that green culture, strategic environmental orientation, leadership, and organizational systems are potential alternative mechanisms.

Cross-nationally, the results also support the notion of a simple ‘one best GHRM bundle’ interpretation. The dominant coefficient pattern varies according to context: opportunity-oriented digital training is most salient in China, and motivation-oriented community rewards are most salient in Pakistan. The positive but weaker path coefficients in Uzbekistan are typical of a transition context where the digital and institutional supports are still in the process of developing. The evidence of the MGA based on permutations shows that the focal structural relationships vary from country to country, and the evidence for the coefficient ordering shows the direction of that variation. The use of individual pairwise permutation p-values is not recorded, so the discussion is made to imply that each mentioned country pair is not significantly different. An exploratory pattern that should be viewed with caution is that green recruitment was highest in Pakistan (β = .27), rather than in China (β = .23). As no directional hypothesis was stated for recruitment, such a difference is considered exploratory and not confirmatory; explanations for the increased salience of eco-skillful selection must be directly tested in future research.

The results cannot be considered as empirical evidence of the new ’Ecosystem-Enabled Green Behavior’ construct. Established dimensions of EGB were measured. The theoretical contribution is more limited: in KIBS, such behaviours can be understood as a boundary spanning interface as the employees are often involved in client-oriented and collaborative innovation processes and transfer environmental knowledge and initiatives to the processes dealing with clients. If the field is interested in directly testing that mechanism, a specific and valid measure of boundary-spanning green behavior should be developed and validated for future studies.

Theoretical implications

First, the study is an extension of the AMO-based GHRM research because it has differentiated the three components (ability, opportunity, and motivation) of GHRM rather than treating GHRM as a global bundle. The outcomes reveal that all of these practices are useful, but vary in salience across countries. This reflects a contingency perspective on AMO, in which the impact of a specific HR lever is contingent on the digital, institutional, and social opportunity context.

Second, it represents an important addition to employee-level research by introducing EGB as the key tested behavioral mediator between GHRM and EIP. This is partly congruent with recent research identifying other mechanisms, including green climate, green knowledge, self-efficacy, pride, and culture (Miah et al., 2024; Sabokro et al., 2021; Zafar & Suseno, 2024). The present model does not obviate those mechanisms, but it demonstrates that a significant amount of the relationship with observable employee behavior accounts for a substantial part of the relationship with innovation outcomes.

Third, the integration is conceptual with value co-creation. Employees of the KIBS often have to operate at the interface of different organizations, and their adoption of greener behaviors can help provide ideas, knowledge, and collaborative effort to externally co-created environmental solutions. This is a new interpretation of EGB, moving beyond internal environmental conduct and more toward a potential micro-foundation of ecosystem innovation, whilst being mindful of the limitations of the current measures.

Managerial implications

Managers should not use a “standard green HR package” for internationalization. Eco-skill screening continues to be relevant in all contexts, but the best investments should be based on the predominant mechanism in each situation. Chinese organizations can highlight the integration of digital technology in green training, collaborative e-learning, knowledge-sharing network, and project-based environmental learning. In Pakistan, it is possible to create environmental incentives that are more tangible by crediting environmental outcomes at the client, community and local level, in addition to rewarding internal efficiency targets. While in Uzbekistan a balance between the development of digital learning capability and credible systems of rewards are more appropriate, it is not realistic to assume that either system is sufficiently developed.

Managerial recommendations are limited to the practices measured in the constructs: digital learning platforms, structured knowledge exchange for the environment, eco-skill recruitment, and transparent reward/recognition based on environmental results. In addition to tracking the adoption of these practices, managers should track whether observed EGB results are associated with these practices.

Limitations and future research

Several limitations qualify the findings. First, the study is cross-sectional, so the reported paths should be interpreted as theoretically specified associations rather than definitive causal effects. Longitudinal or time-lagged designs would be better suited to establishing temporal ordering. Second, the multi-respondent procedure separates the respondent roles used to report GHRM and EGB/EIP, but the 1,256 questionnaire records are associated with 412 firms, and the retained structural model was not estimated with a multilevel or cluster-adjusted procedure. The study reports the n=1,256 analysis sample documented in the submitted statistical summaries and does not infer a different case count from respondent-role totals. The nested structure of questionnaire records within firms is acknowledged as a limitation, and future studies should preserve auditable matched-source files, model nesting directly, or, where theoretically appropriate, report aggregation statistics and estimate models at the corresponding level. Third, the approximately 12% firm-level participation rate raises the possibility of organizational non-response bias; the non-significant early/late respondent comparison does not eliminate that firm-level risk. Fourth, the results are limited to medium-to-large KIBS firms in three Asian contexts and should not be generalized automatically to small firms, manufacturing, or Western economies.

Fifth, ’boundary-spanning EGB’ is an interpretive theoretical mechanism, not a separately operationalized construct in this study. Future research should develop and validate items that directly capture employee environmental collaboration with clients, communities, and policy actors. Sixth, future work should examine leadership, green climate, employee values, digital maturity, and environmental strategy as competing or complementary mechanisms, drawing on the growing literature on green psychological climate and employee-level sustainability (Kaur et al., 2025; Khan et al., 2025; Zafar & Suseno, 2024)

Conclusion

This study examines how differentiated GHRM practices are associated with employee green behavior and environmental innovation performance in KIBS firms across Pakistan, China, and Uzbekistan. Eco-skill-focused recruitment, digitally integrated green training, and community-impact rewards were all positively associated with EGB, and EGB was strongly associated with EIP. Significant bootstrapped indirect effects showed that EGB mediates each GHRM–EIP pathway, with VAF values ranging from 48%–56%; the study does not use VAF alone to classify mediation as partial or full. The permutation-based MGA indicated cross-country heterogeneity, and the directional coefficient pattern was consistent with the proposed contextual expectations: digital training was comparatively strongest in China, community-impact rewards were strongest in Pakistan, and the EGB–EIP relationship was strongest in China. These directional contrasts are interpreted without claiming pairwise significance that was

not directly reported. The results support a context-contingent AMO interpretation: ability, motivation, and opportunity mechanisms remain relevant across countries, but the relative strength of particular HR levers depends on the surrounding institutional and digital contexts. In KIBS, EGB can also be understood as a potential boundary-spanning interface through which internally enabled employees contribute to externally co-created environmental innovation, although this interpretation requires direct empirical measurement in future research.

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Appendix

Measurement items

All items were measured on a five-point Likert scale (1=strongly disagree to 5=strongly agree). The wording below is retained from the submitted instrument.

Independent Variable 1: Green Recruitment with Eco-Skill Focus (Adapted from Tang et al., 2018)

1. Our organization actively recruits candidates with verifiable skills and knowledge in environmental management and sustainability (eco-skills).
2. We highlight our firm's commitment to green innovation and co-creation in our employer branding to attract talent predisposed to collaborative environmental work.
3. A candidate's proven experience or potential for collaborating on cross-functional sustainability projects is a key selection criterion.

Independent variable 2: Green training with digital integration

(Adapted from Teixeira et al., 2016 and Tang et al., 2018).

4. The content of our green training is designed based on an analysis of skill gaps and the digital tools needed for environmental problem-solving and co-creation.
5. Our organization uses integrated digital platforms (e.g., e-learning modules, collaborative software) to deliver green training and facilitate knowledge exchange across teams and functions.
6. The green training provided is relevant and up-to-date, focusing on applying knowledge to current environmental challenges using available digital technologies.
7. Employees are provided opportunities through digital channels to apply, practice, and share green knowledge gained from training in real-world projects.

Independent variable 3: Green rewards with community impact

(Adapted from Tang et al., 2018)

8. Our reward system includes incentives for employee-led green initiatives that demonstrate a positive, measurable impact on the local community or broader environment.
9. We offer significant recognition and non-financial rewards (e.g., organization-wide awards, public acknowledgment) for projects that achieve sustainability goals benefiting external stakeholders or ecosystems.
10. Performance evaluations and financial incentives are explicitly linked to contributions that advance environmental objectives with clear community or societal spillover effects.

Mediating Variable: Employee Green Behavior (EGB) (Adapted from Boiral & Paillé, 2012)

Sub-dimension: Eco-Initiatives

11. In my work, I weigh the consequences of my actions before doing something that could affect the environment.
12. I voluntarily carry out environmental actions and initiatives in my daily work activities.
13. I make suggestions to my colleagues about ways to protect the environment more effectively, even when it is not my direct responsibility.

Sub-dimension: Eco-Civic engagement

14. I actively participate in environmental events organized in and/or by my company.
15. I stay informed of my company's environmental initiatives.
16. I undertake environmental actions that contribute positively to the image of my organization.
17. I volunteer for projects, endeavors, or events that address environmental issues in my organization.

Sub-dimension: Eco-helping

18. I spontaneously give my time to help my colleagues take the environment into account in everything they do at work.
19. I encourage my colleagues to adopt more environmentally conscious behaviour.
20. I encourage my colleagues to express their ideas and opinions on environmental issues.

Dependent Variable: Environmental Innovation Performance (EIP)

Sub-dimension: Green Process Innovation (Adapted from Zhu et al., 2008 and Chih et al., 2019)

21. Our organization has implemented processes that reduce energy consumption during production/service delivery.
22. We have adopted technologies or methods that minimize waste generation in our operations.
23. Our processes are designed to reduce the use of hazardous materials or chemicals.
24. We continuously improve our operations to lower emissions (air, water, waste).
25. We invest in upgrading equipment or software to enhance environmental performance in our workflows.

26. Our processes incorporate recycling, reuse, or recovery of materials.

Sub-dimension: Green product/service innovation (Adapted from Zhu et al., 2008 and Sang & Han, 2023)

27. Our organization designs products/services that consume less material or energy during use.
28. We develop products/services that are reusable, recyclable, or biodegradable.
29. We innovate to avoid or reduce the use of hazardous substances in our products/services.
30. Our new products/services help customers reduce their own environmental impact.
31. We introduce digital or service-based alternatives to physical products to lower environmental footprints.
32. We incorporate customer feedback and co-creation into developing greener products/services.