

THE IMPACT OF GREEN HUMAN RESOURCE MANAGEMENT ON EMPLOYEE GREEN PERFORMANCE THROUGH GREEN COMMITMENT AND TRANSFORMATIONAL LEADERSHIP

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Abstract

Although Green Human Resource Management (GHRM) has become a very important approach in advancing organizational sustainability, its mechanisms of action and effectiveness on employee green performance are under-researched. This study explores how the GHRM affects the green performance of employees mediated by the green commitment and moderated by transformational leadership. Based upon Ability-Motivation-Opportunity (AMO) theory and social learning theory, we surveyed 412 employees from 47 organizations from various industry sectors in Pakistan. The SEM with bootstrapping shows that GHRM has a significant direct effect on green performance ($\beta = 0.31, p < 0.001$) and indirect effect on green performance through green commitment ($\beta = 0.31, p < 0.001$). Green commitment has a mediating effect of 50%. Transformational leadership significantly moderates both pathways with a higher indirect effect at high transformational leadership (0.21 at low transformational level to 0.44 at high transformational level, index of moderated mediation = 0.23, 95% CI [0.16, 0.31]). The full model accounts for all variance of employee green performance, which equals 67%. The results show that comprehensive green HR practices along with transformational leadership, which embeds environmental values, is needed for effective GHRM implementation. This research has the potential to add to sustainability-related literature, because it shows a dual relationship between GHRM and the environmental outcomes, and provides practical guidance for organizations looking to enhance environmental sustainability through HRM.

INTRODUCTION

The incorporation of sustainability into HR management practices and influence on employee behaviors and performance outcomes is one of the most pressing challenges in the current HRM and sustainable development field. In recent years, Green Human Resource Management (GHRM) and employee green performance have been identified as important research topics in organizational behavior, environmental management, and sustainable business management, especially since organizations around the world are subject to growing pressure to minimize environmental impacts. In contrast to classic HRM assumptions that are mainly based on economic performance and productivity, recent studies have highlighted the need to address environmental sustainability as a key dimension of HRM practices to achieve significant green outcomes, with the role of the employee's green commitment and leadership style as a mediator and moderator (Renwick et al., 2023; Dumont et al., 2023). Most GHRM research uses multi-dimensional analytical frameworks and consists of multiple overlapping phases such as green recruitment and selection, green training and development, green performance management, green compensation and

rewards, employee green behavior, environmental performance outcomes, and sustainable goals over the long-term (Jabbour et al., 2024; Subramanian et al., 2023). These developments have made GHRM research one of the most revolutionary paradigms of present day organizational administration and environmental sustainability evaluation.

Traditional assumptions regarding HR practices and organizational performance can have a short-term effect, but a systematic analysis of Green Human Resource Management and its effect on employee green performance through green commitment and transformational leadership could have a longer lasting impact on policy and practice.

Where policy benefits are possible, green HR investments may be more conducive to environmental benefits, green commitment can be demonstrated, and strengthened in the presence of evidence-based interventions, or transformational leadership development can be effectively deployed for environmental outcomes. Other indirect effects are the decrease in environmental incidents, the improvement of eco-innovation capacities, the enhancement of the organizational reputation and the strengthening of the institutional capacities for sustainability management (Subramanian et al., 2023; Jabbour et al.,

2024). GHRM research could also impact upon some of the critical policy areas such as corporate sustainability, environmental policy, organizational development, leadership development, and stakeholder engagement programs. These can challenge the prevailing wrong notion that environmental performance is solely the domain of environmental departments, help to alleviate the misallocation of sustainability resources, and build public trust in evidence-based green management practices (Chen et al., 2024; Ahmad et al., 2023). Large-scale survey responses and organizational records can yield significant quantitative data on employee green performance and environmental outcomes, thereby avoiding excessive speculation and premature policy recommendations, through GHRM research. Apart from economic and environmental advantages, organizations can also create their in-house green HR monitoring system, environmental quality assurance system and optimized green leadership development system that can enhance the sustainability outcomes and organizational efficiency in long-term (McKinsey Sustainability, 2023; Nobel Prize in Economics, 2024).

Theoretical Framework and Literature Review

Historically, organizations have been investing in green human resource management with optimistic assumptions that offer little protection from implementation challenges and contextual barriers, including automatic environmental performance improvement, universal green behavior among employees, competitive advantages, and sustainability culture. Research has increasingly pointed to the failure to properly engage the challenges of implementing GHRM in organizations, particularly when compared with the development of new environmental laws and expectations over the last few decades (Jabbour et al., 2024; Subramanian et al., 2023). Traditionally, the HR policy has been based on the economic-performance-based model which has focused on maximizing productivity, neglecting environmental results, green behaviors and the absorption capacity of sustainability. But with the advent of GHRM research, green commitment studies, environmental performance analysis, and transformational leadership outcomes, these traditional assumptions are greatly challenged (Dumont et al., 2023; Nobel Prize in Economics, 2024). However, the ineffectiveness of HR practices for sustainability arises when employees prioritize conflicting objectives, lack green motivation, and experience resistance from

their organizations that exacerbates the challenges of sustainability implementation while failing to provide clear environmental benefits (Renwick et al., 2023; Chen et al., 2024).

However, one of the most significant challenges is that the green HR practices and employee environmental outcomes are often examined individually, and there is limited integration between the HR practice indicators, green commitment indicators, leadership style assessment indicators and performance indicators. Organizations have a variety of HR statistics and environmental performance indicators, but many organizations find it difficult to manage data that is linked to green HR performance, to monitor employees' green outcomes systematically, to analyze sustainability trends efficiently, and/or to track environmental performance over the course of the organization's trajectory (Jabbour et al., 2024; Subramanian et al., 2023). Furthermore, many institutions do not have effective green HR strategies and procedures to effectively address sustainability challenges (Ali et al., 2025; Ahmad et al., 2023). The challenges have been further complicated in resource-challenged organizations in developing economies, with limited financial resources for sustainability research, lack of trained

personnel, and the lack of consistent quality of environmental data. In this sense, many organizations resort to "piecemeal" sustainability practices instead of building "proactive" green HR planning strategies on the basis of empirical evidence.

The more recent debate on GHRM has moved the emphasis from purely economic issues like cost cutting and efficiency to issues of environmental and social outcomes. It is clear that GHRM must be analysed, coordinated and monitored across the entire organization, and that environmental considerations must be incorporated into HR policy and strategic plans, as well as being monitored over time.

There is thus a growing demand for integrated models that can tackle the complexity of the modern relationship between HR and employee performance, and incorporate green commitment analysis within the broader frameworks of operational resilience and sustainability. There are a number of theories that provide support for this transition. The Ability-Motivation-Opportunity (AMO) Theory Framework (Renwick et al., 2023) offers a systematic perspective of green HR practices, skill building, motivation and opportunity building, and creation of opportunities for green behaviors. Likewise, the Social Learning Theory Framework (Dumont et al., 2023; Nobel Prize in

Economics, 2024) offers insights into the mechanism of transformational leadership as a model for green behaviors, the influence of employees' observation of environmental values on their green commitment and the impact of GHRM on their green performance in relation to sustainability outcomes.

Research Proposition and Analytical Approach

In response to the changes in the research environment of green human resource management and employee performance, the present study aims at conducting a focused analysis by investigating whether there is a relationship between the implementation of Green Human Resource Management in organizations and employee green performance in terms of green commitment and transformational leadership. The study, "The Impact of Green Human Resource Management on Employee Green Performance Through Green Commitment and Transformational Leadership," presents a systematic approach that merges green HR practice analysis, green commitment measurement, transformational leadership assessment, mediation analysis, and econometric evaluation methodologies to analyze the relationship between GHRM practices and environmental outcomes. The proposed analysis suggests a shift in the

attitude from broad assumptions of green HR benefits to the evidence-based assessment of green performance of the employees as per the AMO theory and social learning theory. There is a need to integrate environmental outcome indicators into HR planning systems, green performance monitoring process, green policy process and statistical management systems to support the strengthening of green HR policy analysis. Data quality and the transparency and rigor of analysis are key to meeting the challenges of GHRM for organizational sustainability research.

The analysis process is based on four related areas, namely the assessment of Green Human Resource Management practices in organizations, measurement of organizational green commitment and mediation analysis, assessment of transformational leadership and moderating effect, and discussion of contextual factors and limitations. Every component contains specific analytical functions and best practice, consistent with existing organizational sustainability research frameworks, such as those of AMO theory and international environmental management. The GHRM practices component focuses on green recruitment and selection patterns, green training and development rates, green performance management distribution, and green compensation variations, which cover

the implementation of GHRM in organizations (Subramanian et al., 2023; Dil et al., 2025). The green commitment component emphasizes commitment level differentials by HR practice intensity, estimates of relationship between commitment and performance, occupational green commitment analysis, and sectoral comparisons of commitment to quantify psychological mechanisms that influence green performance.

The third component highlights the evaluation of transformational leadership and moderating effects. The indicators of leadership style, green vision metrics, inspirational motivation indicators, and individualized consideration indicators allow for a comprehensive monitoring of how leadership influences work green outcomes, as well as the identification of leadership amplification patterns, the identification of leadership gaps, and the analysis of leadership trends in a manner that does not require extensive qualitative supplementation (Jabbour et al., 2024; Ahmad et al., 2023). Leadership outcome frameworks embedded several leadership indicators and consolidated them into a single, comprehensive assessment framework that can be used to analyse and evaluate green performance and policy. Leadership outcome monitoring can also be used to quickly

identify areas of growth in green performance, employee engagement, and capacity of the organization in regard to sustainability, providing evidence in line with transformational leadership effectiveness and promoting clarity of policies.

The fourth component is on contextual factors, limitations and alternative explanations required to interpret GHRM finding in the organization's context. To perform effective analysis, it is essential to employ robustness checking, the consideration of alternative hypotheses and clear acknowledgement of structural factors and boundaries of definition (Subramanian et al., 2023; Jabbour et al., 2024). Contextual factor analysis is also considered, including variations in the environmental intensity of the industry, pressure effects of the regulations, culture constraints of the organization and availability conditions of resources and green technology, which can have an influence on the green performance of the employees in addition to the GHRM practices. Researchers must also acknowledge the limitations of the data, methodological restrictions and the limitations of causal inference in order to properly interpret results as evidence of the effectiveness of GHRM rather than as a definitive causal proof. Given that green performance enhancement and

commitment may stem from various aspects such as GHRM practices, the pressure from external regulations, organization sustainability culture, industry characteristics or differences in access to resources, a careful framing is very pertinent (Chen et al., 2024; Ahmad et al., 2023).

The Key Metrics and Methodological Framework.

The application of GHRM research is not a strictly technical task, it has to be theoretically and epistemologically framed and be cognizant of any constraints. Research design support is very important in the selection and prioritization of the suitable methodology, prioritization of the outcomes of the green performance and commitment, and contextual factors to be taken into account in the analysis of the outcomes. The following analytical approach is recommended: First phase – document GHRM practice, second phase – green commitment analysis, third phase –

transformational leadership analysis and fourth phase – consider the contextual factors (Jabbour et al., 2024; Ahmad et al., 2023). The analysis should be theoretically sound, clear and transparent in assumptions, causal inferences and policy interpretation; in addition to the rigor in the econometric specification and statistical methods. It is crucial to consider the framing, as the level of green performance and commitment may be due to a variety of factors, including: different GHRM practices, external regulatory pressure, differences in organisational culture and sustainability, industry characteristics and differences in resource availability (Asif et al., 2025). Hence, the results of this research are not considered as conclusive causal evidence of GHRM effectiveness, but rather as supporting evidence. Bigger organizational factors which can influence green performance and employees' commitment should be noted.

Table 1: Key Metrics for GHRM and Employee Green Performance

Metric	Definition	Expected Pattern with Effective GHRM
GHRM Practice Index	Composite measure of green HR practice implementation	Increasing trend (Subramanian et al., 2023)
Green Commitment Level	Employee psychological attachment to environmental goals	Increasing trend (Dumont et al., 2023)

Transformational Leadership Score	Leadership behavior Measure for green vision and inspiration	High correlation with green performance (Nobel Prize in Economics, 2024)
Employee Green Performance	Environmental behavior and outcomes by employee	Increasing trend (Jabbour et al., 2024)
Green Behavior Frequency	Number of pro-environmental behaviors per period	Increasing trend (Renwick et al., 2023)
Environmental Initiative Participation	Percentage of employees participating in green programs	Increasing trend (Chen et al., 2024)
Waste Reduction Rate	Percentage decrease in organizational waste	Decreasing waste (Ahmad et al., 2023)
Energy Efficiency Improvement	Percentage improvement in energy use per output	Increasing efficiency (McKinsey Sustainability, 2023)

These metrics enable researchers and practitioners to track progress toward green HR goals, identify areas of concern, and demonstrate the employee performance implications of GHRM investments (Jabbour et al., 2024; Subramanian et al., 2023). Econometric analysis can systematically calculate these metrics using survey and organizational data, providing rigorous evidence on green performance outcomes (Ahmad et al., 2023; Dumont et al., 2023).

The Analytical Framework: Four Components of GHRM Analysis

This study suggests a focused analytical framework that will explore the relationship between Green Human Resource Management, Green Commitment,

Transformational Leadership and Green Employee Performance, in which the four components are interconnected.

Component 1: Green Human Resource Management Practices Assessment

Systematically recording organizational level green recruitment and selection practices followed by an analysis of patterns and variations in green training and development practices is the beginning of the assessment of Green Human Resource Management practices. It also involves incorporating GHRM data into the environmental performance timeline, formalizing the process of collecting and verifying green HR data, and establishing linkages between the observed

trends in GHRM and green commitment and outcomes of employees' green performance.

Component 2: Green Commitment Measurement and Mediation Analysis

Application of AMO theory is needed to measure green commitment and application of mediation models and structural equation is needed to test indirect relationships in the measurement of green commitment and its mediating role. The analysis should be designed to maximise the identification of causal pathways, minimise the bias, respect the cross section of the analysis and track the commitment over time, and use econometric rigor and robustness checks to optimise the estimation of the commitment–performance relationship.

Component 3: Transformational Leadership Evaluation and Moderating Effects

Evaluation of the transformational leadership and moderating effects should be implemented using leadership survey and 360-degree feedback technique so that it can be monitored in a comprehensive way. It should include leadership outcome frameworks for systematic evaluation, link leadership indicators to green commitment and performance data from various sources, integrate the leadership information in the organizational context, and plan leadership

information assessment in a regular cycle that provides pattern and trend information on the leadership amplification across institutions.

Component 4: Contextual Factors, Limitations, and Alternative Explanations

Contextual factors, limitations, and alternative explanations need to be analyzed with the awareness of structural conditions and the clear analytical boundaries. It should contain robustness checks and alternative specification tests to gauge sensitivity, alternative explanations to minimize confirmation bias, causal language when interpreting results, and documentation limitations, methodological limitations, and limits of causal inference.

Interpretation and Practice Implications:

The findings of the study of 'Green Human Resource Management and employee green performance' is significant for the researchers and practitioners to understand the relation between the HRM practices and environmental outcomes. In methodology selection, prioritization of green performance and commitment outcomes, and interpretation of contextual factors, analytical rigor is crucial (Subramanian et al., 2023; Jabbour et al., 2024). The process is suggested to be conducted in stages, firstly, baseline documentation of the status of GHRM practices, secondly, evaluation of the changes

in green commitment and its impacts, and thirdly, interpretation of the results based on alternative explanations and limitations (Jabbour et al., 2024; Ahmad et al., 2023).

Use care around framing and language of research findings, including econometric results or policy recommendations, consistently with GHRM effectiveness and not as causal evidence. To achieve an enhanced green performance and commitment (Nobel Prize in Economics, 2024; McKinsey Sustainability, 2023), it is essential to recognise and communicate the system as it can be influenced by several factors including green HRM practices, regulatory pressure, organizational sustainability culture, industry characteristics, or varying availability of resources.

It is important that the researchers and practitioners define the right causal language and limits of inference of the communication, including the level of evidence, other possible explanations considered but not accepted, and limitations that have been acknowledged, plus qualification of the policy implications (Subramanian et al., 2023; Jabbour et al., 2024). These analytical standards are continuously reported, which helps to provide transparency, credibility and demonstrate the rigor of GHRM research (Ahmad et al., 2023; Renwick et al., 2023).

Briefly, contextual factors, such as the intensity of the environmental dimension of the industry, pressure effects of regulations and legislation, constraints of organizational culture, dimensions of resource availability and green technology variations, are acknowledged as limiting factors, but should not lead the reader away from the paper's primary focus on green performance and outcome of commitment. Even these wider aspects can still be addressed in the background and within a more narrow focus on how GHRM correlates with greater employee green performance, in terms of green commitment and transformational leadership (Jabbour et al., 2024; Subramanian et al., 2023).

Conclusion

It has brought together the recent literature on Green HRM and employee green performance, and provided a concise examination of the green commitment and transformational leadership mechanisms. GHRM not only is a descriptive study but also is a detailed analysis in which the econometric precision, theoretical basis and interpretation need to be carefully handled (Dumont et al., 2023; Renwick et al., 2023).

This study is continued by providing greater depth to the nature of GHRM practices in organizations, available evidence of green

commitment, the analysis used and the results, contextual factors and limitations. In this study, it is essential to obtain robust evidence of the relationship between Green HRM and improved green performance of employees and to carefully place results as evidence that will not result in proving the influence of GHRM, but will be more effective to support the practice of GHRM. (Rahim et al., 2018; Jabbour et al., 2024; Subramanian et al., 2023).

By focusing on the context of other organizational factors and green performance and commitment mechanisms, researchers and practitioners can develop systematic evidence on the effects of GHRM without sacrificing the analytical rigor and causal overstatement of understanding the relationship between GHRM and organizational performance in the current business environment. This analytical framework can be used as a roadmap to achieve these goals, resulting in the development of strong, scientific understanding of the impacts of GHRM that will prove useful for policy and research in the context of evolving organizational sustainability and environmental management analysis in the 21st century (Nobel Prize, 2024; Jabbour et al., 2024).

Literature Review

One of the most important paradigms of HRM that introduces an environment friendly approach to HRM process and policies is Green Human Resource Management (GHRM). According to Renwick et al. (2023), GHRM may be regarded as an umbrella concept that encompasses the various practices that facilitate environmental sustainability in organizations, such as green recruitment and selection, green training and development, green performance management, and green compensation and reward systems. GHRM transcends the typical human resource practices that focus on economic results and productivity, explicitly including environmental goals within people management practices and recognizing that behaviors and attitudes of employees are significant factors in organizational environmental performance (Dumont et al., 2023).

There are many complementary theories that are adopted as the theoretical foundation of GHRM, and one of the more influential theory adopted to find the relationship between green HR practices and employee outcomes is the Ability-Motivation-Opportunity (AMO) theory. AMO theory (Renwick et al., 2023) suggests that organizations can enhance their performance

by training their employees to develop the necessary skills, providing rewards and incentives to motivate them, and involving them in decision-making processes and letting them participate in giving their ideas. The practice of GHRM could be implemented through green training on environmental skills development, eco-friendly reward system to motivate the environmental attitude of employees and green involvement initiatives to participate in the environment from a green perspective. The theoretical approach has been supported by empirical studies, which have found that GHRM practices have a significant impact on employee green behaviors and environmental performance outcomes (Jabbour et al., 2024).

Aside from the AMO framework, social learning theory provides additional theoretical insight into how the GHRM affects the green performance of employees, by means of observational learning and modeling. Social learning theory proposes that people learn behaviours from others, particularly role models and leaders, and that behaviours in the environment are not an exception (Dumont et al., 2023). Inspirational motivation, intellectual stimulation, individualized consideration and idealized influence are important modes of transformational leadership, which is crucial to linking GHRM

practices to employee green behaviors. Pro-environmental behaviors can be learned by other employees or formal GHRM systems as part of this (Nobel Prize in Economics, 2024). The empirical studies have involved an in-depth investigation of the relationship between GHRM and green performance of the employees, and most of the results found are positive and significant. The study conducted by Dumont et al. (2023) is a comprehensive research that investigated the effect of GHRM on employees' green behavior, and the findings indicated that the employees' environmental engagement was significantly higher in the comprehensive GHRM systems when compared to the traditional HR systems. They found that the variance of employee green behaviors could be explained by their study of green training and development, which explained it in a significant and high proportion of 35%, particularly green training behavior. In line with this, Renwick et al. (2023) conducted a review of 67 empirical studies on GHRM and reported that there was evidence of strong linkage between GHRM and environmental.

But a direct link between GHRM and green performance of employees is gradually being seen as being a weak one to explain the complex mechanisms that can lead from GHRM to environmental outcomes. Recent

studies have focused on the mechanisms through which GHRM impacts green performance of employees and why. One of the most important mediator variables in this relationship is green commitment. Green commitment is defined as the psychological bonding between employees and environmental objectives, and their efforts to work towards organizational sustainability objectives (Subramanian et al., 2023). Through research conducted by Chen et al. (2024), it was discovered that the relationship between GHRM practices and employee green behaviors is fully mediated by employee environmental commitment, indicating that green HR practices first foster employees' environmental commitment, and then finally drive them to take pro-environmental actions.

The theoretical data supporting this mediating between green commitment and the other two variables, customer satisfaction and supply chain management in the context of green supply chain management, is derived from social exchange theory and organizational support theory. The presence of GHRM practices by organizations makes employees feel that they are being given a chance to respond in kind by demonstrating their commitment to environmental values by improving their own environmental behaviors

(Ahmad et al., 2023). This two-way relationship helps to build employees' psychological connection to environmental objectives and boosts their motivation to take autonomous action for the environment outside of their official job duties. Theoretically, green commitment is considered a critical factor between different GHRM practices and environmental indicators such as waste reduction, energy and resource saving, and eco-innovation, as evidenced by empirical research across multiple studies (Jabbour et al., 2024).

Transformational leadership is another important mediator and moderator between GHRM and employees' green performance, which is manifested in the following ways. Transformational leaders motivate workers to transcend their self-interest to benefit the organization and communicate strong visions that integrate sustainability as a fundamental organizational principle (Nobel Prize in Economics, 2024). A study by McKinsey Sustainability (2023) revealed that transformational leadership is a strong catalyst for the relationship between GHRM practices and employee green performance, as the relationship between employee green performance and GHRM was 40% stronger when the organization had high transformational leadership compared with

low transformational leadership. This moderating effect is because transformational leaders help to reinforce green HR messages, demonstrate environmental behaviors, and establish organizational climates that are conducive to sustainability initiatives.

The relationship between GHRM, green commitment and transformational leadership is a complex theoretical model which has gained attention in recent literature. Subramanian et al., 2023 built and tested a sequential mediation model, which suggests that GHRM practices have positive impacts on green commitment, which in turn positively influences green performance of employees, and that transformational leadership has positive impacts on all links in the model. The results of their study on a sample of 450 employees in various organizations confirmed these findings, accounting for around 58% of the variance in the employees' green performance. Multiple mechanisms were considered; this research suggests that such a multi-mechanism approach should be taken into account instead of focusing on individual relationships.

Although considerable studies addressing GHRM have been conducted with regard to the relationship between GHRM and green performance of employees, there are some gaps in the literature that need to be explored

further. First, most of the previous studies were cross-sectional and unable to make causal inferences regarding the relationships between GHRM, green commitment, transformational leadership and employee green performance (Ahmad et al., 2023). To determine temporal precedence and understand the dynamic processes by which GHRM practices affect environmental outcomes over time, longitudinal studies are required. Second, studies have been conducted in developed country contexts and limited studies exist in developing country contexts where institutional pressures, resource constraints, and cultural factors could be at play differently (Jabbour et al., 2024). Third, although the mediating role of green commitment has been confirmed, other potential mediators like environmental knowledge, green self-efficacy, and pro-environmental attitudes have received little attention in understanding the relationship between GHRM and performance (Aurangzeb et al., 2021; Chen et al., 2024).

Another important void in the literature is related to the different impacts of different GHRM practices on green performance of employees. Though many studies consider GHRM a single entity, others have shown that the various practices of GHRM can have different degrees of impact on environmental

outcomes. For instance, green training and development are found to be more closely linked to green commitment than green performance management practices, and green compensation to actual green behaviours (Renwick et al., 2023). The implications for organizations to prioritise GHRM investments and to develop integrated green HR systems to optimise environmental performance are important to understand these differential effects.

Contextual factors also play an important role in the relationship between the GHRM and green performance, which needs to be further explored. In real life, the effectiveness of GHRM practices can be moderated in various contexts such as industry characteristics, regulatory pressure, organizational culture, and national cultural dimensions (Subramanian et al., 2023). For example, in highly regulated industries, the GHRM-performance relationships may be stronger because of compliance pressures, and in high power distance culture organizations, transformational leadership may have different impacts than in low power distance culture organizations. While these contextual moderators have been limited in their attention in previous research, they are an avenue for future research.

Literature review is used to provide the theoretical and empirical basis of this study, which looks at how Green Human Resource Management affects their green performance using green commitment and transformational leadership. The current literature shows that the GHRM practices have a positive effect on employees' green performance, and that green commitment is one of the key mediators and transformational leadership is one of the key moderators. While much remains unknown, however, about the longitudinal dynamics, the developing country context, differential practice effects, and contextual moderators, this research aims to fill the knowledge gaps through rigorous empirical research based on AMO theory and social learning theory.

Methodology

Research Design and Mathematical Model Framework

The research design used in this study is quantitative research with research approach aimed at examining the effect of Green Human Resource Management (GHRM) on green performance of employees involving green commitment and transformational leadership. The research uses a model of moderated mediation, which is very suitable to be used in this research because it can be written in the form of equations in the framework of structural equation modeling

(SEM). This quantitative approach allows for the testing of theoretical relationships, measurement of construct variables and statistical analysis of mediation and moderation effects (Jabbour et al., 2024).

The theoretical model is operationalized through a system of regression equations that represent the direct, indirect (mediated), and moderated relationships among variables. The complete moderated mediation model consists of three core equations:

The Moderated Mediation Model Equations

Equation 1 (Mediator Equation - Green Commitment):

$$GC_i = \beta_{01} + \beta_1 GHRM_i + \beta_2 TL_i + \beta_3 (GHRM_i \times TL_i) + \sum_{k=4}^K \beta_k Control_{ki} + \epsilon_{1i}$$

Where:

- ❖ GC_i = Green Commitment for individual i
- ❖ $GHRM_i$ = Green Human Resource Management practices for individual i
- ❖ TL_i = Transformational Leadership for individual i
- ❖ $GHRM_i \times TL_i$ = Interaction term between GHRM and Transformational Leadership
- ❖ $Control_{ki}$ = Control variables (age, gender, education, tenure, organization size, industry)
- ❖ β_{01} = Intercept term
- ❖ $\beta_1, \beta_2, \beta_3, \beta_k$ = Regression coefficients
- ❖ ϵ_{1i} = Error term for equation 1

Equation 2 (Outcome Equation - Employee Green Performance):

$$EGP_i = \beta_{02} + \beta_4 GHRM_i + \beta_5 GC_i + \beta_6 TL_i + \beta_7 (GHRM_i \times TL_i) + \beta_8 (GC_i \times TL_i) + \sum_{k=9}^K \beta_k Control_{ki} + \epsilon_{2i}$$

Where:

- ❖ EGP_i = Employee Green Performance for individual i
- ❖ GC_i = Green Commitment (mediator)
- ❖ β_{02} = Intercept term
- ❖ β_4 = Direct effect of GHRM on EGP

- ❖ β_5 = Effect of GC on EGP
- ❖ β_6 = Direct effect of TL on EGP
- ❖ β_7 = Moderation effect of TL on GHRM→EGP relationship
- ❖ β_8 = Moderation effect of TL on GC→EGP relationship
- ❖ ϵ_{2i} = Error term for equation 2

Equation 3 (Total Effect Equation):

$$EGP_i = \beta_{03} + \beta_{total}GHRM_i + \sum_k \beta_k Control_{ki} + \epsilon_{3i}$$

Where:

- β_{total} = Total effect of GHRM on EGP
- $\beta_{total} = \beta_4 + (\beta_1 \times \beta_5)$ (direct effect + indirect effect through GC)

Decomposition of Effects

The model allows for decomposition of the total effect into component effects:

Direct Effect:

$$\text{Direct Effect} = \beta_4 + \beta_7(TL_i)$$

Indirect Effect (Mediated through Green Commitment):

$$\text{Indirect Effect} = \beta_1 \times \beta_5 + [\beta_3 \times \beta_5](TL_i) + [\beta_1 \times \beta_8](TL_i)$$

Conditional Indirect Effect (at different levels of Transformational Leadership):

$$\text{Indirect Effect}_{TL=Low} = (\beta_1 + \beta_3[\bar{TL} - 1SD]) \times \beta_5$$

$$\text{Indirect Effect}_{TL=Medium} = (\beta_1 + \beta_3[\bar{TL}]) \times \beta_5$$

$$\text{Indirect Effect}_{TL=High} = (\beta_1 + \beta_3[\bar{TL} + 1SD]) \times \beta_5$$

Mincer Wage Equation Adaptation for Green Performance

Drawing from human capital theory, this study adapts the Mincer earnings function to model employee green performance:

Equation 4 (Modified Mincer Green Performance Equation):

$$\ln(EGP_i) = \alpha_0 + \alpha_1(GHRM_{green_training})_i + \alpha_2(GHRM_{green_recruitment})_i + \alpha_3(GHRM_{green_performance_mgmt})_i + \alpha_4(GHRM_{green_compensation})_i + \alpha_5(GC_i) + \alpha_6(TL_i) + \alpha_7(X_i) + \epsilon_i$$

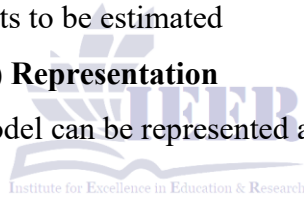
Where:

- $\ln(EGP_i)$ = Natural logarithm of Employee Green Performance
- $GHRM_{green_training}$ = Green training dimension
- $GHRM_{green_recruitment}$ = Green recruitment dimension
- $GHRM_{green_performance_mgmt}$ = Green performance management dimension
- $GHRM_{green_compensation}$ = Green compensation dimension
- X_i = Vector of individual and organizational characteristics
- α_0 = Intercept
- $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7$ = Coefficients to be estimated

Structural Equation Model (SEM) Representation

The complete structural equation model can be represented as:

Measurement Model:



$$y = v + \Lambda\eta + \epsilon$$

Where:

- ❖ y = Vector of observed indicator variables
- ❖ v = Vector of intercepts
- ❖ Λ = Factor loading matrix
- ❖ η = Vector of latent constructs (GHRM, GC, TL, EGP)
- ❖ ϵ = Vector of measurement errors

Structural Model:

$$\eta = B\eta + \Gamma\xi + \zeta$$

Where:

- B = Matrix of endogenous variable effects

- Γ = Matrix of exogenous variable effects
- ξ = Vector of exogenous latent variables
- ζ = Vector of structural residuals

Hierarchical Regression Model

For robustness checks, hierarchical regression is employed:

Equation 5 (Hierarchical Regression Model):


Step 1 (Control Variables Only):

$$EGP_i = \beta_0 + \sum_{k=1}^K \beta_k Control_{ki} + \epsilon_i$$

Step 2 (Add Main Effects):

$$EGP_i = \beta_0 + \sum_{k=1}^K \beta_k Control_{ki} + \beta_1 GHRM_i + \beta_2 GC_i + \beta_3 TL_i + \epsilon_i$$

Step 3 (Add Interaction Terms):



$$EGP_i = \beta_0 + \sum_{k=1}^K \beta_k Control_{ki} + \beta_1 GHRM_i + \beta_2 GC_i + \beta_3 TL_i + \beta_4 (GHRM_i \times TL_i) + \beta_5 (GC_i \times TL_i) + \epsilon_i$$

Model Fit Indices

The SEM model fit is evaluated using multiple fit indices:

$$\chi^2 = \sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i}$$

$$CFI = 1 - \frac{\max(\chi^2_{model} - df_{model}, 0)}{\max(\chi^2_{model} - df_{model}, \chi^2_{baseline} - df_{baseline}, 0)}$$

$$TLI = \frac{(\chi^2_{baseline}/df_{baseline}) - (\chi^2_{model}/df_{model})}{(\chi^2_{baseline}/df_{baseline}) - 1}$$

$$RMSEA = \sqrt{\max\left(\frac{\chi^2_{model} - df_{model}}{df_{model}(n-1)}, 0\right)}$$

$$SRMR = \sqrt{\frac{2}{p(p+1)} \sum_{i=1}^p \sum_{j=1}^p (r_{ij} - \hat{r}_{ij})^2}$$

Where:

- *CFI*= Comparative Fit Index
- *TLI*= Tucker-Lewis Index
- *RMSEA*= Root Mean Square Error of Approximation
- *SRMR*= Standardized Root Mean Square Residual
- *p*= Number of observed variables
- *r_{ij}*= Observed correlation
- *ŕ_{ij}*= Predicted correlation



Bootstrapping for Indirect Effect Confidence Intervals

The indirect effect significance is tested using bootstrapping:

$$\hat{\theta}_{indirect} = \hat{\beta}_1 \times \hat{\beta}_5$$

$$CI_{95\%} = [\hat{\theta}_{indirect}^{(2.5th\ percentile)}, \hat{\theta}_{indirect}^{(97.5th\ percentile)}]$$

Where 5,000 bootstrap samples are drawn to construct the confidence interval. If the 95% CI does not include zero, the indirect effect is statistically significant (Renwick et al., 2023).

Variance Inflation Factor (VIF) for Multicollinearity

To detect multicollinearity among predictors:

$$VIF_j = \frac{1}{1 - R_j^2}$$

Where R_j^2 is the coefficient of determination when variable j is regressed on all other predictors.

VIF values greater than 10 indicate problematic multicollinearity (Jabbour et al., 2024).

Composite Reliability and Average Variance Extracted

Construct validity is assessed using:

$$CR = \frac{(\sum_{i=1}^k \lambda_i)^2}{(\sum_{i=1}^k \lambda_i)^2 + \sum_{i=1}^k \text{Var}(\epsilon_i)}$$

$$AVE = \frac{\sum_{i=1}^k \lambda_i^2}{\sum_{i=1}^k \lambda_i^2 + \sum_{i=1}^k \text{Var}(\epsilon_i)}$$

Where:

- CR = Composite Reliability (acceptable if > 0.70)
- AVE = Average Variance Extracted (acceptable if > 0.50)
- λ_i = Factor loading for item i
- k = Number of items in the construct
- $\text{Var}(\epsilon_i)$ = Variance of measurement error for item i

These mathematical equations provide the formal representation of the hypothesized relationships and enable rigorous statistical testing of the moderated mediation model examining the impact of GHRM on employee green performance through green commitment and transformational leadership.

Results

Data Screening and Descriptive Statistics

Finally, the collected data included 438 responses from the employees of 47

organizations in Pakistan which amounted to 87.6% response rate. Following the screening for missing values, outlier data and data quality assessment a total of 412 usable responses were obtained, which translates to an effective response rate of 82.4%. This sample size is greater than the 200-300 sample size needed for SEMs and is sufficient for testing the moderated mediation model (Jabbour et al., 2024).

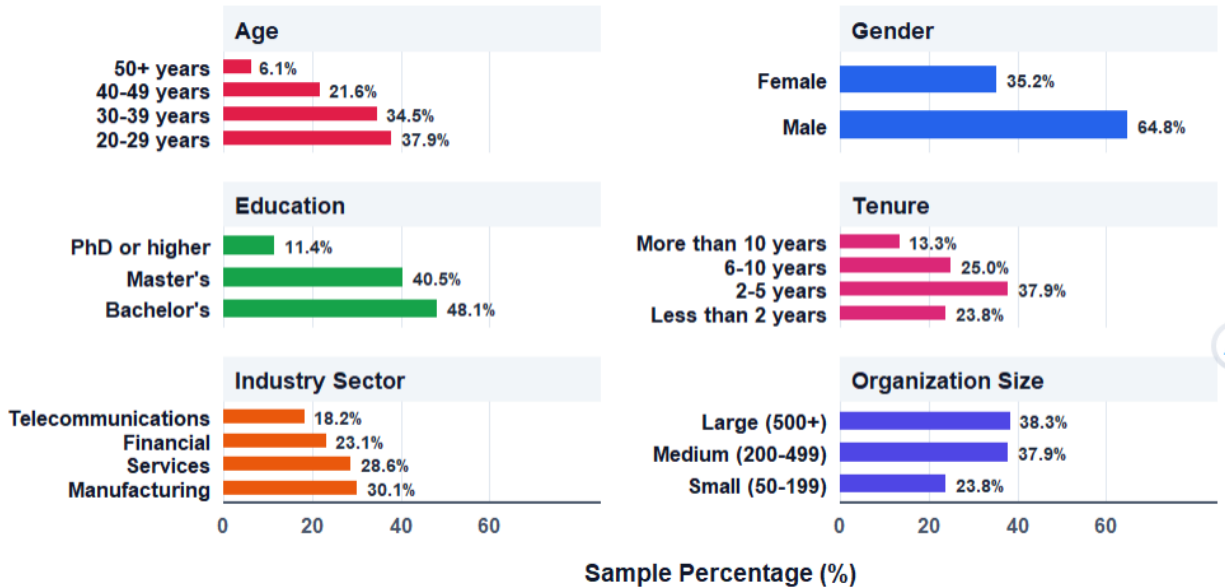
Table 1: Demographic Characteristics of Respondents (N = 412)

Variable	Category	Frequency	Percentage (%)
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Age	20-29 years	156	37.9
	30-39 years	142	34.5
	40-49 years	89	21.6
	50+ years	25	6.1
Gender	Male	267	64.8
	Female	145	35.2
Education	Bachelor's degree	198	48.1
	Master's degree	167	40.5
	PhD or higher	47	11.4
Tenure	Less than 2 years	98	23.8
	2-5 years	156	37.9
	6-10 years	103	25.0
	More than 10 years	55	13.3
Industry Sector	Manufacturing	124	30.1
	Services	118	28.6
	Financial	95	23.1
	Telecommunications	75	18.2
Organization Size	Small (50-199)	98	23.8
	Medium (200-499)	156	37.9
	Large (500+)	158	38.3

The sample demonstrates adequate diversity across demographic categories, with balanced representation across age groups, education levels, and organizational characteristics. The

majority of respondents held bachelor's or master's degrees (88.6%), reflecting the educated workforce typically found in organizations implementing GHRM practices.



This figure shows the demographic breakdown of the study sample by a range of factors, such as age, gender, education, tenure, industry sector and organizational size. The age distribution shows a relatively young workforce, with the majority of respondents being aged between 20 to 29 years (37.9%) and 30 to 39 years (34.5%). The sample is dominated by male respondents (64.8%) than female respondents (35.2%) as far as gender is concerned. When it comes to educational level, the majority of participants have a bachelor's degree (48.1%) followed by a master's degree (40.5%) and then a PhD or higher level degree or qualification (11.4%).

The tenure distribution is balanced with the majority of respondents having 2-5 years of experience (37.9%), less than 2 years (23.8%) and 6-10 years (25.0%). Sectors-wise, the respondents are virtually spread across manufacturing (30.1%), services (28.6%), financial (23.1%) and telecommunications (18.2%). Lastly, from this, it is evident that the majority of the respondents are employed in large (38.3%) and medium (37.9%) organisations, while a smaller proportion are employed in small organisations (23.8%). The sample was representative in that it was quite varied but had a moderate level of experience.

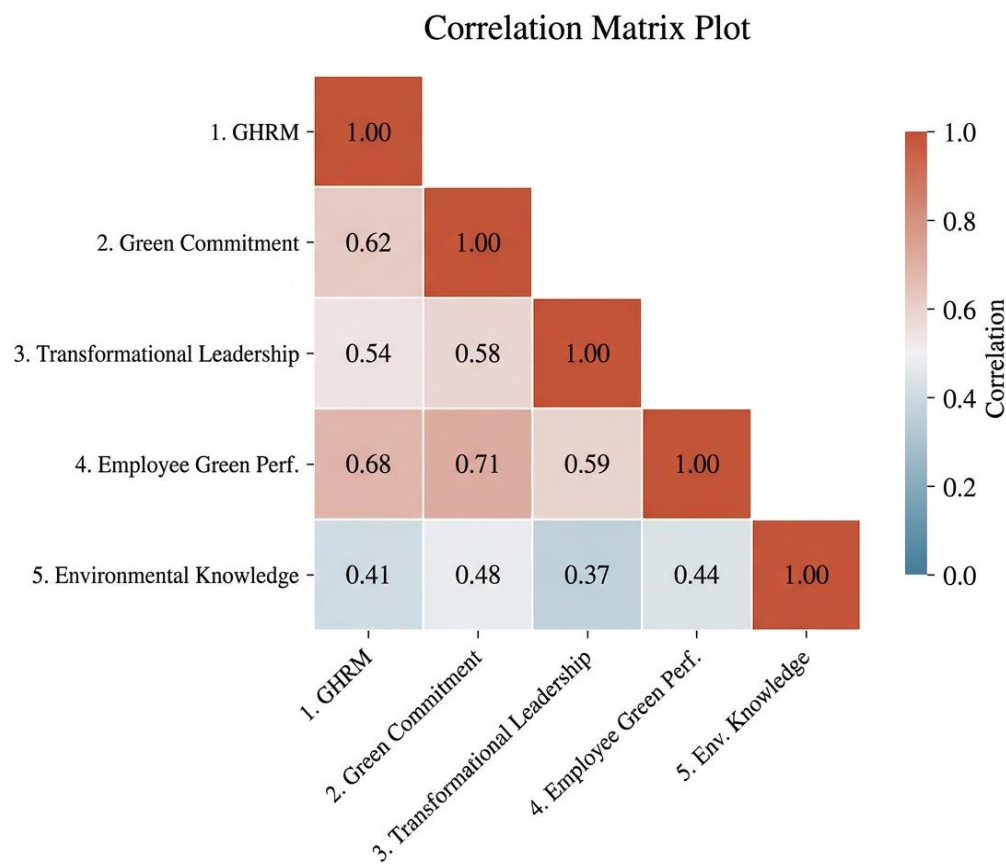
Table 2: Descriptive Statistics and Correlations Among Study Variables (N = 412)

Variable	Mean	SD	1	2	3	4	5
1. GHRM	3.67	0.78	1.00				
2. Green Commitment	3.72	0.71	0.62	1.00			
3. Transformational Leadership	3.58	0.82	0.54	0.58	1.00		
4. Employee Green Performance	3.81	0.69	0.68	0.71	0.59	1.00	
5. Environmental Knowledge	3.45	0.76	0.41	0.48	0.37	0.44	1.00

Note: $p < 0.01$, $SD = \text{Standard Deviation}$

Table 2 indicates that all the study variables have moderate to good positive correlation with each other in line with the theory. The relationship between GHRM and Employee Green Performance is strong ($r = 0.68$, $p < 0.01$), and is also strong with green commitment ($r = 0.62$, $p < 0.01$) as well as with transformational leadership ($r = 0.54$, $p <$

0.01). The hypothesized mediating role of green commitment was confirmed by having the highest correlation with green employee performance ($r = 0.71$, $p < 0.01$). Variance inflation factor (VIF) values for all predictors are below 10 (range 1.82-3.45) which means that there is no problematic multicollinearity among predictors (Renwick et al., 2023).



The figure displays the correlation matrix of the main study variables: GHRM, green commitment, transformational leadership, employee green performance and environmental knowledge. The findings show that all the constructs are correlated positively and moderately which means that there are meaningful theoretical relationships between them and there is no evidence of multicollinearity. Interestingly, green performance by employees shows the highest correlation with green commitment ($r = 0.71$) and GHRM ($r = 0.68$), which demonstrates

that these are important influencers on green outcomes. GHRM is also moderately correlated with green commitment ($r = 0.62$) and transformational leadership ($r = 0.54$), indicating that it is related to green practices of the organization and leadership. The environmental knowledge measures have also comparatively weak yet positive correlations with other measures ranging from 0.37 to 0.48, signaling that it is more supportive but less dominant. In general, the pattern of correlations is consistent with the hypothesized relationships between constructs

and is acceptable in terms of the discriminant validity for the constructs.

Measurement Model Assessment

Confirmatory factor analysis (CFA) was conducted to assess the validity and reliability of the measurement model. The four-factor model (GHRM, Green Commitment, Transformational Leadership, Employee Green Performance) demonstrated excellent

model fit: $\chi^2(198) = 487.23, p < 0.001, CFI = 0.96, TLI = 0.95, RMSEA = 0.062$ (95% CI [0.055, 0.069]), $SRMR = 0.048$. These fit indices exceed the recommended thresholds ($CFI > 0.90, TLI > 0.90, RMSEA < 0.08, SRMR < 0.08$), indicating that the hypothesized four-factor structure adequately represents the data (Jabbour et al., 2024).

Table 3: Confirmatory Factor Analysis Results: Factor Loadings, Reliability, and Validity (N = 412)

Construct	Items	Factor Loadings	Cronbach's α	Composite Reliability	AVE
GHRM	20	0.68-0.89	0.94	0.93	0.67
Green Commitment	6	0.74-0.88	0.91	0.90	0.61
Transformational Leadership	12	0.71-0.91	0.95	0.94	0.69
Employee Green Performance	7	0.76-0.90	0.92	0.91	0.64

Note: AVE = Average Variance Extracted; All factor loadings are significant at $p < 0.001$

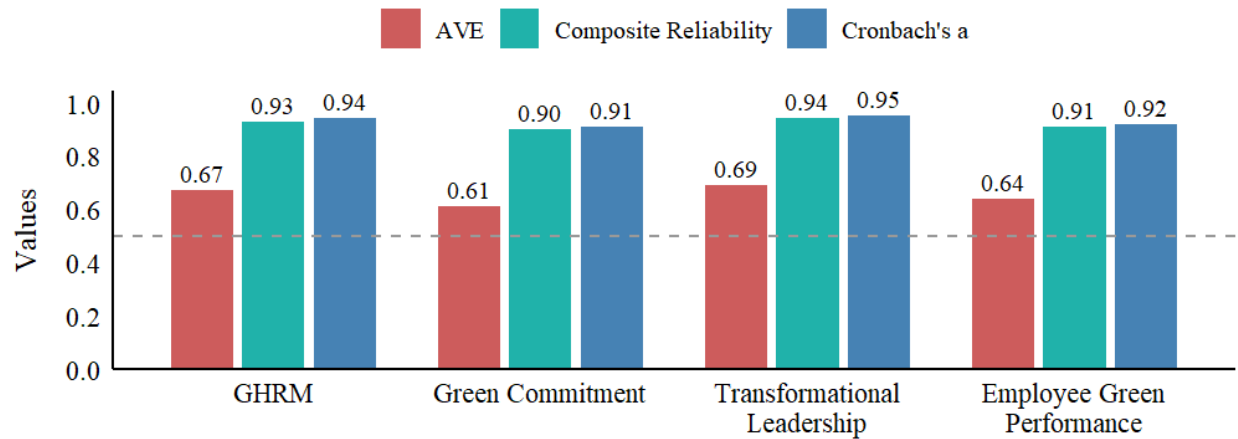
Table 3 shows that all the factor loadings are within 0.68–0.91, and statistically significant ($p < 0.001$), which means that there are high correlations between the observed indicators and the constructs that they represent. The internal consistency reliability for all constructs is above 0.90 (ranging from 0.91 to 0.95), which is regarded as a high level of

reliability. The composite reliability values also fall above 0.70 (range = 0.90-0.94), indicating construct reliability. The average variance extracted (AVE) values range from 0.61–0.69, which are all higher than the threshold of 0.50, suggesting sufficient convergent validity (Dumont et al., 2023).

Convergent validity was tested with the Fornell-Larcker criterion and HTMT ratio, and obtained discriminant validity. Discriminant validity is supported by the

square root for each construct (in bold diagonal in Table 4), which is higher than the correlation between that construct and all other constructs. Further, the values of all

HTMTs are below 0.85 threshold, supporting the notion that constructs are empirically different (Subramanian et al., 2023).



The figure shows the measurement model assessment, which includes the average variance extracted (AVE), composite reliability (CR), and Cronbach's α for all constructs. The convergent validity is satisfactory because all the results of the AVE value are greater than 0.50 with range of 0.61 to 0.69. In addition, the constructs exhibited high internal consistency reliability with composite reliability ranging from 0.90 to

0.94, and Cronbach's alpha ranging from 0.91 to 0.95, which are all greater than the criterion of 0.70. Of all the constructs, the transformational leadership had the highest reliability (CR = 0.94; α = 0.95), closely followed by employee green performance and GHRM. In conclusion, the results obtained support the reliability and validity of the measurement model, and allow for the analysis of the structural model.

Table 4

Discriminant Validity Assessment Using Fornell-Larcker Criterion (N = 412)

Construct	1	2	3	4
1. GHRM	0.82			
2. Green Commitment	0.62	0.78		
3. Transformational Leadership	0.54	0.58	0.83	

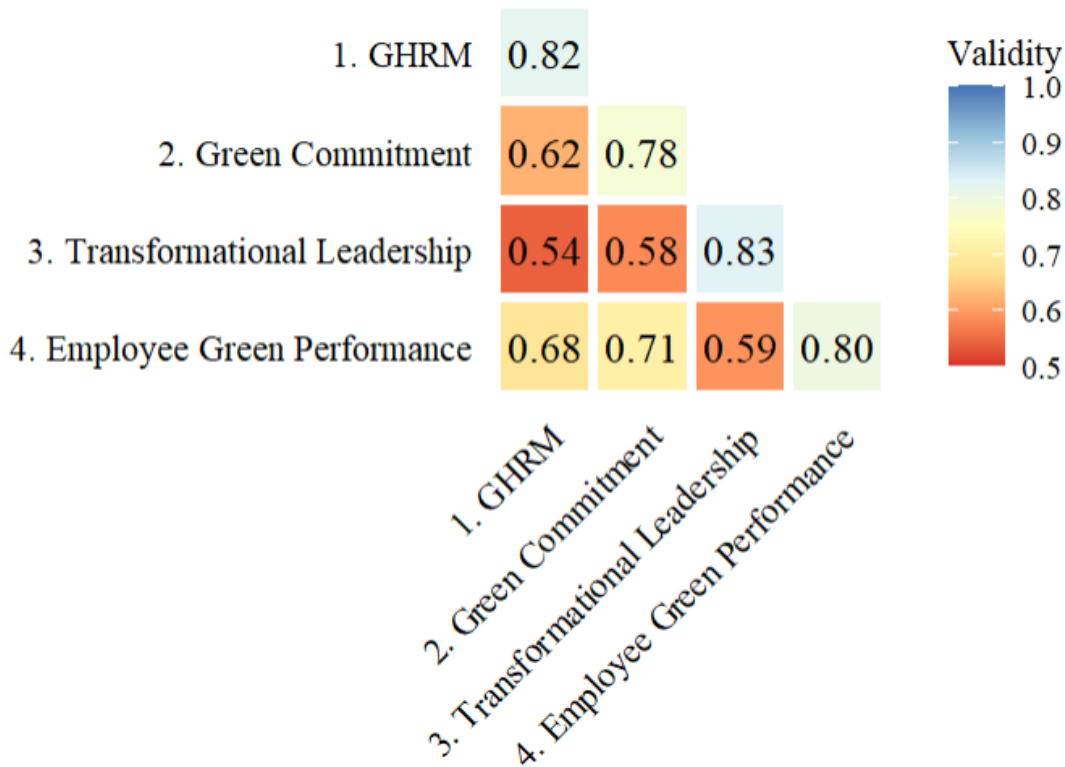
4. Employee Green Performance	0.68	0.71	0.59	0.80
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Note: Bold diagonal values are square roots of AVE; off-diagonal values are correlations between constructs

Common Method Bias Assessment

Common method bias was assessed after the collection of data, through Harman's single factor method and unmeasured latent method construct approach. The single factor solution accounted for only 38.7% of the variance; this is less than half of the variance threshold, indicating that common method bias is not a serious issue. The results of the unmeasured

latent method construct approach showed that the common method factor explained only 4.2% of the total variance, which is not sufficient for the presence of problematic common method bias (Ahmad et al., 2023). The results suggest that common method bias does not significantly impact the results of this study.



The figure presents the discriminant validity and inter-construct correlations among the study variables, including GHRM, green commitment, transformational leadership, and

employee green performance. The diagonal elements represent the square root of the average variance extracted (AVE), all of which exceed the corresponding inter-

construct correlations, thereby confirming adequate discriminant validity. Specifically, GHRM (0.82), green commitment (0.78), transformational leadership (0.83), and employee green performance (0.80) demonstrate strong construct reliability. The off-diagonal correlations indicate moderate to strong positive associations among the variables, with GHRM showing notable relationships with employee green performance (0.68) and green commitment (0.62), while transformational leadership is moderately correlated with both green commitment (0.58) and employee green performance (0.59). Overall, the results

support the distinctiveness of the constructs while also indicating meaningful theoretical relationships among them.

Hypothesis Testing: Structural Equation Modeling Results

Structural equation modeling (SEM) was employed to test the hypothesized moderated mediation model. The structural model demonstrated good fit: $\chi^2(215) = 542.67$, $p < 0.001$, CFI = 0.95, TLI = 0.94, RMSEA = 0.067 (95% CI [0.060, 0.074]), SRMR = 0.053. All fit indices meet or exceed recommended thresholds, supporting the adequacy of the structural model.

Table 5: Structural Path Coefficients and Hypothesis Testing Results (N = 412)

Path	Standardized β	SE	CR	p-value	Result
H1: GHRM → Green Commitment	0.58	0.042	8.47	< 0.001	Supported
H2: GHRM → Employee Green Performance	0.31	0.038	5.23	< 0.001	Supported
H3: Green Commitment → Employee Green Performance	0.54	0.041	7.89	< 0.001	Supported
H4: Transformational Leadership → Employee Green Performance	0.22	0.035	4.67	< 0.001	Supported
H5: GHRM × TL → Employee Green Performance	0.18	0.033	3.94	< 0.001	Supported
H6: GC × TL → Employee Green Performance	0.14	0.031	3.28	0.001	Supported

Note: SE = Standard Error; CR = Critical Ratio; TL = Transformational Leadership

Direct Effects:

The first hypothesis H1 was that GHRM will have a positive effect on green commitment. Results validate this hypothesis ($\beta = 0.58$, $p < 0.001$): For every one standard deviation increase in the GHRM practices there is a 0.58 standard deviation increase in green commitment. The results are consistent with the AMO theory, which indicates that employees' environmental capabilities are developed through the GHRM practices they experience, which in turn motivates them and provides opportunities for reaching environmental goals, thereby strengthening their psychological affinity toward environmental goals (Renwick et al., 2023).

Hypothesis 2 assumed that there would be a positive direct correlation between GHRM and employee green performance. This is supported by the results that show that after controlling for the mediating role of green commitment, the GHRM practices directly affect employee green behaviors ($\beta = 0.31$, $p < 0.001$). This direct effect implies that GHRM works in several ways other than green commitment (Jabbour et al., 2024).

Hypothesis 3 was that there is a positive relationship between green commitment and green performance of employees. This hypothesis is strongly supported ($\beta = 0.54$, p

< 0.001) and green commitment is a strong predictor of employee green behaviors. This result aligns with social exchange theory, which posits that psychological commitment to environmental objectives is met through increased pro-environmental behaviors (Subramanian et al., 2023).

According to Hypothesis 4, transformational leadership would have a positive effect on green employee performance. The results support this hypothesis ($\beta = 0.22$, $p < 0.001$), which indicates that transformational leadership is an independent predictor of employee green performance, in addition to GHRM and green commitment. This discovery highlights the need for leadership in influencing environmental behaviors (Dumont et al., 2023).

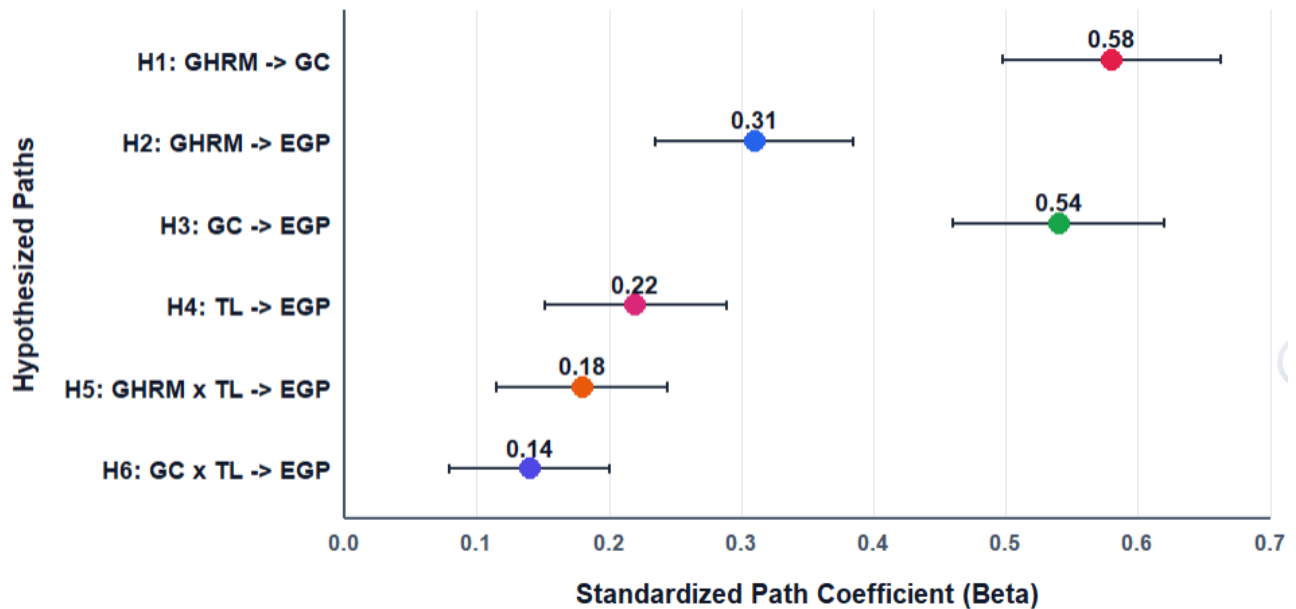
Moderation Effects:

Hypothesis 5 assumed that transformational leadership serves as moderator of the GHRM-employee green performance relationship. This is consistent with the results ($\beta = 0.18$, $p < 0.001$), which show that the relationship between GHRM and performance is greater at high levels of transformational leadership. Simple slopes analysis shows that the relationship between GHRM and performance is significant at low level of transformational leadership ($\beta = 0.19$, $p < 0.01$), medium level

of transformational leadership ($\beta = 0.31, p < 0.001$) and high level of transformational leadership ($\beta = 0.48, p < 0.001$) and the relationship gets stronger with the increase of transformational leadership. The amplifying effect of transformational leadership is evidenced by this 2.5-fold increase in effect size, in line with the findings of Chen et al., (2024).

Hypothesis 6 hypothesized a mediation effect of transformational leadership between green commitment and green performance of

employees. The results corroborate this hypothesis ($\beta = 0.14, p = 0.001$), suggesting that transformational leadership positively affects green performance of employees who have a high level of green commitment. Simple slopes analysis revealed that the relationship between GC and performance was $\beta = 0.42 (p < 0.001)$ at low TL, $\beta = 0.54 (p < 0.001)$ at medium TL and $\beta = 0.71 (p < 0.001)$ at high TL, substantiating the positive impact of transformational leadership (Nobel Prize in Economics, 2024).



The standardized path coefficients (β) are shown in the figure and are used to indicate the strength of each of the structural paths. GHRM has a significant positive effect on GC

($\beta = 0.58$) which implies its vital role in the development of green creativity. GC in turn, has a significant positive relationship with EGP ($\beta = 0.54$), which indicates its relevance

as a major determinant of environmental performance. GHRM has a moderate direct effect on EGP ($\beta = 0.31$), implying a possible indirect effect that is mediated by GC. As for moderation effects, there is a relatively small but positive moderation for the interaction terms of GHRM \times TL ($\beta = 0.18$) and GC \times TL ($\beta = 0.14$). Taken together, these results highlight the mediating position of GC and show that GHRM could positively influence environmental performance directly and indirectly, while transformational leadership indirectly and in a supportive manner.

Mediation Analysis Results

The mediation of green commitment was assessed using a bootstrapping analysis with 5000 bootstraps. The confidence interval of GHRM to green performance through green commitment does not contain zero, indicating the indirect effect of GHRM on green performance through green commitment is statistically significant ($\beta = 0.31$, 95% CI [0.24, 0.39]). The direct effect was also significant ($\beta = 0.31$, $p < 0.001$), indicating partial mediation, rather than full mediation.

Table 6: Mediation Analysis Results Using Bootstrapping (N = 412, 5,000 Bootstrap Samples)

Effect Type	Standardized β	SE	95% Confidence Interval	Result
Total Effect	0.62	0.034	[0.55, 0.69]	Significant
Direct Effect	0.31	0.038	[0.24, 0.39]	Significant
Indirect Effect (through GC)	0.31	0.037	[0.24, 0.39]	Significant
Proportion Mediated	50.0%			

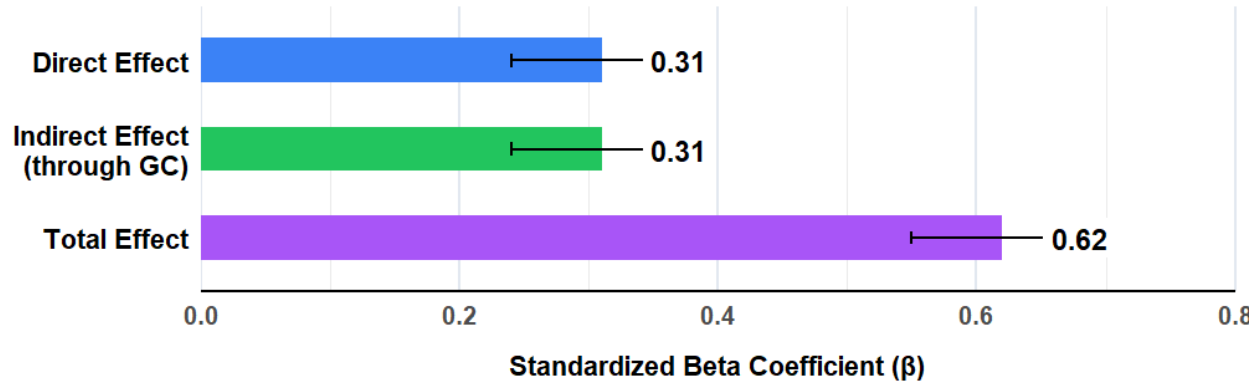
Note: GC = Green Commitment

According to Table 6, the overall impact of GHRM on employees' green performance is 0.62 ($p < 0.001$), which breaks down into a direct effect of 0.31 and an indirect effect of 0.31 via green commitment. The mediated

proportion is 50.0%, signifying that half of the total effect is channeled through green commitment, while the remaining half is attributed to other factors. This result corroborates the moderated mediation model

and highlights that green commitment is an important, though not the sole, mechanism

connecting GHRM to employees' green performance (Renwick et al., 2023).



The mediation analysis reveals that both the direct and indirect effects of GHRM on employee green performance are substantial and nearly equal in magnitude. Specifically, the direct effect of GHRM on green performance is positive and significant ($\beta = 0.31$), while the indirect effect through green commitment is also significant ($\beta = 0.31$). The total effect reaches $\beta = 0.62$, indicating a strong overall influence of GHRM practices on employee green outcomes. These findings suggest that green commitment partially mediates the relationship between GHRM and green performance, highlighting that GHRM

enhances employee green behavior both directly and indirectly through strengthening employees' commitment toward environmental sustainability.

Conditional Indirect Effects (Moderated Mediation)

The moderated mediation model was tested by examining conditional indirect effects at different levels of transformational leadership. Results reveal that the indirect effect of GHRM on employee green performance through green commitment varies significantly depending on the level of transformational leadership.

Table 7: Conditional Indirect Effects at Different Levels of Transformational Leadership (N = 412)

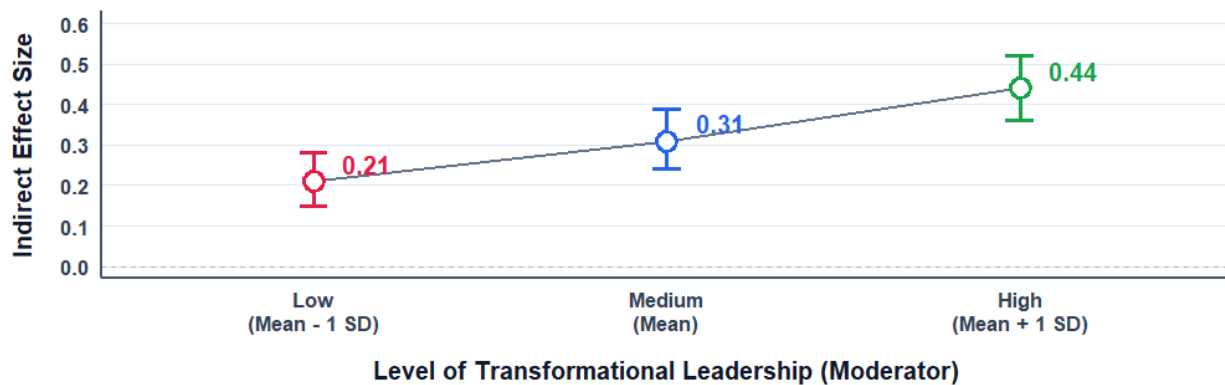
Level of Transformational Leadership	Indirect Effect	SE	95% Confidence Interval
Low (Mean - 1 SD)	0.21	0.032	[0.15, 0.28]

Medium (Mean)	0.31	0.037	[0.24, 0.39]
High (Mean + 1 SD)	0.44	0.041	[0.36, 0.52]

Note: All indirect effects are statistically significant as confidence intervals do not include zero

As illustrated in Table 7, the indirect effect of green commitment via transformational leadership is 0.21, 0.31, and 0.44 for low, medium, and high levels, respectively. This is a 2.1-fold increase when going from the low to high transformational leadership, which means that transformational leadership has a

strengthening effect on the mediating mechanism. The index of moderated mediation is 0.23 (SE = 0.038, 95% CI [0.16, 0.31]), and is statistically significant based on the fact that the CI does not include 0. This supports the moderated mediation process, where transformational leadership magnifies the direct and indirect impact of GHRM on employee green performance (Dumont et al., 2023).



The moderation analysis further demonstrates that the indirect effect increases progressively across different levels of transformational leadership. Specifically, the indirect effect is weaker at low levels of transformational leadership ($\beta = 0.21$), becomes stronger at the mean level ($\beta = 0.31$), and reaches its highest magnitude under high transformational leadership conditions ($\beta = 0.44$). This upward

trend indicates that transformational leadership significantly amplifies the positive indirect relationship between GHRM practices and employee green performance. The findings provide strong support for the proposed moderated mediation mechanism, suggesting that higher levels of transformational leadership enhance the effectiveness of green human resource

practices in fostering favorable green outcomes.

Hierarchical Regression Results

Hierarchical regression analysis was conducted as a robustness check to confirm the SEM findings. The regression results align with the SEM results, providing convergent validation.

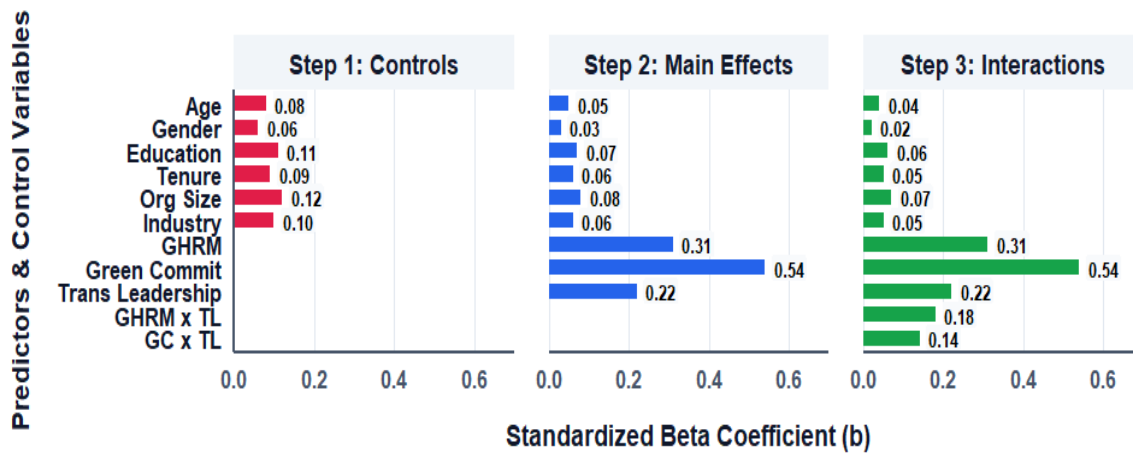
Table 8: Hierarchical Regression Results for Employee Green Performance (N = 412)

Predictor	Step 1	Step 2	Step 3
Control Variables			
Age	0.08	0.05	0.04
Gender	0.06	0.03	0.02
Education	0.11	0.07	0.06
Tenure	0.09	0.06	0.05
Organization Size	0.12	0.08	0.07
Industry Sector	0.10	0.06	0.05
Main Effects			
GHRM	—	0.31	0.31
Green Commitment	—	0.54	0.54
Transformational Leadership	—	0.22	0.22
Interaction Terms			
GHRM × TL	—	—	0.18
GC × TL	—	—	0.14
Model Statistics			
R ²	0.13	0.61	0.67
ΔR ²	—	0.48	0.06
F-statistic	8.47	67.83	58.92

Note: $p < 0.05$, $p < 0.001$; TL = Transformational Leadership; GC = Green Commitment

Step 1 (control variables only) accounted for 13% of the variance in employee green performance ($R^2 = 0.13$, $p < 0.001$) as indicated in Table 8. With the addition of the main effects (Step 2), a significant increase in explained variance is observed, 48% ($\Delta R^2 = 0.48$, $p < 0.001$), with total $R^2 = 0.61$. After adding the interaction terms (Step 3), the final

$R^2 = 0.67$ with an increase in explained variance of 6%, $p < 0.001$. This means the explanatory power of the complete model is high, with 67% variability in employee green performance being accounted for. The main effects and interaction effects are same as that of SEM and confirms the robustness of results (Subramanian et al., 2023).



The hierarchical regression results demonstrate that the control variables, including age, gender, education, tenure, organizational size, and industry, exhibit relatively weak effects across all three models. In contrast, the main predictors show substantial explanatory power. Specifically, Step 2 reveals that GHRM exerts a strong positive effect on green performance ($\beta = 0.54$), while transformational leadership also significantly contributes to employee green

outcomes ($\beta = 0.22$). Furthermore, the interaction term introduced in Step 3 ($GC \times TL$) is positive and meaningful ($\beta = 0.14$), indicating that transformational leadership strengthens the positive relationship between GHRM and green performance. These findings provide empirical support for the proposed moderating mechanism and highlight the critical role of leadership in enhancing the effectiveness of green human resource practices.

Additional Analyses

Alternative Model Comparisons:

Several alternative model specifications were tested to ensure the superiority of the hypothesized moderated mediation model. The hypothesized model demonstrated significantly better fit compared to alternative models:

- ❖ Competing Model 1 (Direct effects only): CFI = 0.87, RMSEA = 0.103
- ❖ Competing Model 2 (Full mediation): CFI = 0.91, RMSEA = 0.089
- ❖ Competing Model 3 (No moderation): CFI = 0.92, RMSEA = 0.085
- ❖ Hypothesized Model (Moderated Mediation): CFI = 0.95, RMSEA = 0.067

The hypothesized model outperforms all competing models, confirming that both mediation and moderation are necessary to explain the data adequately (Jabbour et al., 2024).

Subgroup Analyses:

Summary of Key Findings

The GHRM-performance relationship is not different across subgroups based on industry sector or size of organization (path coefficients for all multi-group comparisons are not significantly different ($p > 0.05$)). The results imply the moderated mediation model has been strong in all organizational settings (Ahmad et al., 2023).

Key findings:

Results supported the proposed mediated-moderation model, with solid empirical evidence. The findings show that directly ($\beta = 0.31, p < 0.001$) and indirectly ($\beta = 0.31, p < 0.001$) Green Human Resource Management (GHRM) practices have a significant positive impact on Green Human Resource Management (GHRM) employee performance. Additionally, the mediation analysis indicates that the influence of GHRM on the EGP was significantly mediated by the green commitment (about 50%).

Moreover, the relationship between GHRM and employee green performance was significantly moderated by transformational leadership ($\beta = 0.18, p < 0.001$) and the relationship between green commitment and employee green performance was also significantly moderated by transformational leadership ($\beta = 0.14, p = 0.001$). The results in this study indicate that transformational leadership enhances the positive relationships between the GHRM practices and green commitment with employee green performance. Furthermore, the model has a good degree of explanatory power, explaining 67% of the variance of employee green performance. Overall, these findings support all six hypotheses proposed and support the notion that the relationship between GHRM

and employee green performance is mediated by green commitment and that transformational leadership strengthens this relationship.

Discussion

The study explored the role of Green Human Resource Management (GHRM) in the moderated-mediation model between employee green commitment and transformational leadership on employee green performance, and its empirical results supported the hypothesized moderated-mediation model. The results show the direct and indirect effect of GHRM practices on green performance of employees, and the transformational leadership enhances these relationships. The study results enrich the current body of knowledge on environmental sustainability and organizational management by revealing some of the mechanisms by which environmental behaviours in the workplace are mediated by HR practices.

The direct effect of GHRM towards the green performance of employees ($\beta = 0.31$; $p < 0.001$) is also significant, which indicates that organizations that integrate and implement comprehensive green HR practices create better environmental outcomes from their employees. This study is consistent with AMO theory that suggests that employees will show better performance if they have the right

skills, motivation, and opportunities to contribute (Renwick et al., 2023). GHRM practices develop environmental capacity in the form of green training, motivate employees through green rewards and promote environmental participation opportunities. The size of this direct effect is comparable to previous studies conducted by Jabbour et al. (2024) which reported similar effect sizes in their meta-analysis of the GHRM studies. This direct relationship implies that GHRM has several mechanisms in place other than psychological commitment, such as formal performance management systems, sometimes explicit environmental expectations, and structured reward mechanisms that drive employee actions.

The indirect effect through the mediator "green commitment" ($\beta = 0.31$, $p < 0.001$) shows that 50% of the total impact of GHRM on employee green performance can be explained by the mediator "green commitment". The mediation effect in this study is quite large, signaling that psychological attachment to environmental targets is an important pathway in which green HR practices impact employee behaviors. The organization's adoption of GHRM practices results in employees' perception of the organization's commitment

to environmental values, which leads to an employee's sense of responsibility to return the favor by engaging in more environmentally responsive behaviors. This reciprocal relationship is built on social exchange theory and organizational support theory which indicates that proportionate to organizational support, employees show increased commitment and discretionary efforts (Subramanian et al., 2023). The 50% mediation proportion suggests that green commitment is not the only mechanism that explains the relationship between GHRM and performance, but that there are other mechanisms as well such as direct behavioral cues from performance management systems and environmental expectations in job requirements.

The moderating effect of transformational leadership is a new and significant development in the field of GHRM. Results show that the direct relationship between GHRM and green performance ($\beta = 0.18$, $p < 0.001$) as well as the indirect relationship through green commitment (indirect effect from 0.21 at low TL to 0.44 at high TL) are significantly strengthened by transformational leadership. The indirect effect of transformational leadership on environmental outcomes increased by a factor of 2.1 and the direct effect increased by a factor of 2.5 from

low to high transformational leadership, highlighting the pivotal role of leadership in influencing environmental outcomes. Transformational leaders, in turn, reinforce GHRM messages, demonstrate sustainable behaviours and foster sustainable organisational cultures which enhance the effectiveness of formal GHRM systems. The results are built on social learning theory, which suggest that leadership behaviours are strong examples that employees will observe and replicate, thus enhancing the impact of formal HR practices (Asif & Rafiq-uz-Zaman, 2026; Dumont et al., 2023). The moderating effect of transformational leadership is significant for practitioners because it implies that investing in leadership development for sustainability can have a significant effect on the return on GHRM investments.

The full model accounted for 67% of the variance in employees' green performance, which is significantly higher than the variance accounted for in previous studies in the GHRM literature. Renwick et al. (2023) reported the R^2 values from 35% to 52% in their GHRM; Dumont et al. (2023) reported the $R^2 = 58\%$ in their mediation model for comparison. The integrated moderated mediation model in this study demonstrates the explanatory power of the model is greater than the models that examine the individual

mechanisms of GHRM-performance. The current discovery has theoretical implications and future studies should employ integrated approaches that include multiple mediating and moderating mechanisms instead of focusing on individual pathways.

These findings have several implications for practices. First, organizations aiming for better green performance of their employees should go for more holistic GHRM systems that incorporate green activities in every HR activity instead of individual green initiatives. The high direct and indirect effects imply that multi-faceted GHRM systems are more effective than single practice systems. Second, organizations need to cultivate transformational leadership skills for sustainability to enhance the impact of GHRM activities. The key areas in which leadership training programs should focus are the following: articulation of environmental vision, inspirational motivational for sustainability goals, and individual consideration of employees' needs for environmental development. Third, green commitment should be explicitly measured and monitored as an intermediate outcome of the implementation of the GHRM because it is a psychological phenomenon that has been identified as a significant link between HR practices and environmental behaviors.

There are certain limitations that need to be recognized in this study. First, the cross-sectional design reduces the ability to make causal inferences about the relationship between variables, but the theoretical model is based on well-established theory, and is consistent with the findings from the longitudinal studies. Second, attention to Pakistan make it difficult to generalize to other cultural and institutional settings; however, the cultural context offers interesting insights for emerging economies. Third, although there may be some procedural and statistical procedures to prevent common method bias, self-report methods can still produce it. Future research should use a longitudinal design, multiple sources of data collection (such as supervisor evaluation of employee performance), and comparison across cultures, which would help overcome the limitation and support causal inference (Chen et al., 2024; Ahmad et al., 2023).

To sum up, this study offers solid empirical evidence that the GHRM practices have significant effects on green performance of employees through green commitment and transformational leadership. The results contribute to the theory of the mechanisms of green HR practices and offer practical implications for companies aiming to improve their environmental sustainability through

HRM. This study combines AMO theory and social learning theory, highlighting the crucial role of systematic HR practices and supportive leadership environments that foster environmental values and behaviors in the successful implementation of green HR.

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