American Journal of Economic and Management Business
e-ISSN: 2835-5199
Vol. 5 No. 11 November 2026

Beyond Mean Differences: A Three-Tier Approach to Level and Structural Heterogeneity in Green HRM Research

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Keywords:
green human resource management; green strategic HRM; level heterogeneity; structural heterogeneity; ANOVA.

Abstract

Green Human Resource Management (GHRM) research has expanded rapidly; however, empirical studies frequently treat organizations as homogeneous, conflating differences in construct levels with differences in structural relationships. This study addresses this methodological gap by proposing and empirically illustrating a three-tier approach to examining level and structural heterogeneity in GHRM research within a decentralized higher education setting. The research was conducted at Universidade Nacional Timor Lorosa'e (UNTL), Timor-Leste, involving 150 lecturers and administrative staff members equally distributed across ten faculties. Five constructs were examined: Leadership Integrity (LI), Personal Planning (PP), Employee Commitment (EC), Green Strategic Human Resource Management (GSHRM), and Sustainability Performance (SP). Each construct was measured using ten reflective indicators rated on a five-point Likert scale, and the data were analyzed using partial least squares structural equation modeling (PLS-SEM). The analytical procedure comprised three tiers: descriptive analysis of faculty-level means, one-way analysis of variance (ANOVA) to assess level heterogeneity, and Chow tests to evaluate the overall equality of structural coefficients across faculties. The results revealed statistically significant differences in construct means across faculties for all five constructs, with GSHRM exhibiting the largest F-statistic ($F = 33.984$, $p < .001$). The Chow tests further indicated the rejection of the null hypothesis of complete coefficient equality for the EC, GSHRM, and SP equations, providing evidence of structural heterogeneity. Notably, the largest ANOVA F-statistic indicates greater differentiation in construct levels rather than stronger heterogeneity in the underlying structural relationships. The study concludes that level heterogeneity and structural heterogeneity represent distinct analytical dimensions and that differences in construct means should not be interpreted as evidence of differences in causal mechanisms. A staged analytical approach, progressing from omnibus structural tests to path-specific multigroup analysis, is recommended for future research.

INTRODUCTION

Green Human Resource Management (GHRM) has emerged as an important area of sustainability-oriented management research. Earlier studies established GHRM as the integration of environmental objectives into human resource policies and practices, while subsequent empirical research has examined its relationships with employee green behavior, environmental performance, organizational sustainability, and green innovation (Al-Swidi et al., 2021; Chaudhary, 2020; Tang et al., 2018).

Recent reviews demonstrate that the field has expanded substantially. Paulet et al. (2021) highlight the increasing scope of GHRM research, while more recent bibliometric and systematic reviews indicate a growing emphasis on employee green behavior, sustainability, innovation, and organizational environmental outcomes (Joshi et al., 2023; Shah et al., 2024). Consequently, GHRM research has progressively evolved from a narrow focus on environmentally oriented HR practices toward a broader perspective on organizational sustainability.

Higher education represents an important yet distinctive organizational context (Chan & Tsi, 2023; Tierney, 2023). Universities simultaneously function as educational institutions, employers, knowledge-producing organizations, and societal stakeholders. Recent empirical studies have identified relationships between GHRM and sustainability outcomes in higher education institutions, including evidence from developing countries (Abbas et al., 2022; Mohammed & Fisal, 2023). Other studies have examined GHRM within educational institutions from strategic and systems-oriented perspectives (Goel et al., 2022).

However, higher education institutions are rarely organizationally homogeneous. Universities are typically organized into faculties, schools, departments, and administrative units. Although these units operate under shared institutional policies, they may differ in leadership practices, professional norms, resource availability, employee experiences, and sustainability-related practices.

This organizational diversity raises an important methodological question: If Faculty A has a higher mean Green Strategic Human Resource Management (GSHRM) score than Faculty B, does this necessarily indicate that the organizational mechanisms underlying GSHRM differ between the two faculties? Not necessarily. The faculties may exhibit different levels of GSHRM while the structural relationships among Leadership Integrity, Personal Planning, Employee Commitment, and GSHRM remain statistically equivalent. Conversely, two faculties may demonstrate similar mean GSHRM scores while exhibiting substantially different structural relationships between Employee Commitment and GSHRM.

The central methodological concern in GHRM research is the potential conflation of level heterogeneity with structural heterogeneity when examining decentralized organizations. Many empirical studies employ structural equation modeling (SEM) to investigate relationships among constructs, often estimating pooled models that assume structural relationships are equivalent across organizational subunits unless heterogeneity is explicitly assessed. However, universities are rarely monolithic institutions; although faculties and departments operate under shared institutional policies, they may differ considerably in leadership styles, professional norms,

organizational cultures, and resource availability. Previous research suggests that contextual variations in leadership, organizational culture, and resources can influence GHRM-related outcomes (Usman et al., 2024; Vázquez-Brust et al., 2023). Failure to distinguish whether faculties differ primarily in their mean construct scores (level heterogeneity) or in the relationships among constructs (structural heterogeneity) may result in misleading theoretical interpretations and poorly targeted managerial interventions.

A review of the existing literature indicates that although numerous studies have examined the direct and mediated relationships between GHRM and outcomes such as employee green behavior and sustainability performance (Marrucci et al., 2021; Saeed et al., 2019), questions concerning measurement invariance and structural heterogeneity across organizational subunits have received comparatively limited attention. For example, research in higher education has investigated the mediating roles of green organizational culture and environmental values in relationships between GHRM and organizational performance, while systematic reviews have identified the determinants and consequences of GHRM practices. However, studies that aggregate observations across organizational units without explicitly testing subgroup differences may overlook the possibility that structural relationships, such as those linking Employee Commitment to GSHRM, vary across faculties within the same university.

This limitation highlights an important research gap: the need for a systematic analytical framework capable of distinguishing level heterogeneity from structural heterogeneity in GHRM research within decentralized organizational settings. Mean comparisons alone cannot establish whether structural coefficients differ across groups, while omnibus structural tests identify overall differences without necessarily determining which individual relationships are responsible. Consequently, relying exclusively on either approach may produce incomplete interpretations of organizational heterogeneity. This methodological concern is particularly relevant to Universidade Nacional Timor Lorosa'e (UNTL), Timor-Leste, where ten faculties operate within a shared institutional structure. Without assessing the equality of structural coefficients across these faculties, conclusions regarding the consistency of GHRM-related relationships across organizational units may remain insufficiently supported, potentially limiting the usefulness of research findings for institutional decision-making.

The importance of this research is reinforced by the growing global emphasis on campus sustainability and the contribution of higher education institutions to achieving the United Nations Sustainable Development Goals (SDGs). As universities in developing countries seek to strengthen their sustainability performance, they increasingly require evidence-based approaches to managing human resources and implementing environmentally responsible organizational practices. If the structural relationship between Leadership Integrity and GSHRM differs significantly between the Faculty of Engineering and the Faculty of Philosophy, for example, a uniform HR policy may not produce equivalent outcomes across these organizational units. The methodological relevance of this issue is further strengthened by advances in partial least squares structural equation modeling (PLS-SEM), particularly the availability of procedures for assessing measurement invariance and conducting multigroup analysis (MGA) (Henseler et al., 2016;

Liengaard, 2024). Nevertheless, the application of these procedures to examine organizational heterogeneity within higher education GHRM research warrants further investigation.

The novelty of this study lies in its explicit three-tier analytical approach, which extends beyond conventional mean comparisons to distinguish between level heterogeneity and structural heterogeneity. The first tier examines descriptive differences in construct means across faculties, the second evaluates the statistical significance of these differences using one-way analysis of variance (ANOVA), and the third assesses the overall equality of structural coefficients across faculties using Chow tests (Chow, 1960). This third tier provides an omnibus assessment of structural heterogeneity and establishes a methodological basis for subsequent path-specific multigroup analysis using PLS-SEM. Rather than assuming that statistically significant mean differences necessarily reflect different underlying structural relationships, the proposed approach treats these dimensions as analytically distinct. By examining organizational subunits within a single university, the study offers a more context-sensitive framework for investigating heterogeneity in GHRM-related relationships across decentralized academic settings.

The primary purpose of this research is to empirically illustrate and assess the applicability of a three-tier methodological approach for examining level and structural heterogeneity in GHRM research, using UNTL as the empirical setting. Specifically, the study investigates differences in the levels of Leadership Integrity, Personal Planning, Employee Commitment, GSHRM, and Sustainability Performance across faculties and evaluates whether the structural coefficients associated with these constructs are statistically equivalent across organizational units. By distinguishing differences in construct levels from differences in structural relationships, the study seeks to demonstrate the importance of organizational heterogeneity for theoretical interpretation and evidence-based human resource management in higher education.

The contribution of this study is twofold. Theoretically, it advances GHRM research by emphasizing the conceptual and empirical distinction between level heterogeneity and structural heterogeneity, thereby questioning the assumption that organizational subunits necessarily share equivalent structural relationships. This distinction provides a more nuanced understanding of how leadership, employee-related factors, and sustainability-oriented HR practices may operate across decentralized organizational contexts. Methodologically, the study presents a replicable analytical framework that integrates descriptive comparisons, one-way ANOVA, and omnibus structural coefficient tests. Within this framework, Chow tests serve as an initial diagnostic procedure for identifying overall structural differences, while subsequent path-specific multigroup analyses can determine which relationships contribute to the observed heterogeneity. Importantly, comparisons of latent constructs across groups also require consideration of measurement invariance to ensure that observed differences are substantively interpretable. Accordingly, the proposed framework contributes to the development of more rigorous and context-sensitive approaches to organizational heterogeneity in GHRM research.

The objective of this research is to implement a sequential analytical procedure comprising three stages: first, describing variations in construct means across faculties; second, examining statistically significant level heterogeneity using one-way ANOVA; and third, assessing structural

heterogeneity by testing the overall equality of structural coefficients across the ten faculties. Ultimately, the study offers potential benefits for both academic research and institutional practice. For scholars, it provides an analytical framework that reduces the risk of interpreting mean differences as evidence of distinct structural or causal mechanisms. For university administrators and HR practitioners, the findings may inform the development of more context-sensitive GHRM interventions by identifying whether organizational differences primarily concern construct levels or structural relationships. Such evidence can support more targeted sustainability initiatives and contribute to the development of environmentally responsible organizational practices across higher education institutions.

METHOD

Research Setting

The empirical study was conducted at Universidade Nacional Timor Lorosa'e (UNTL), Timor-Leste, involving ten faculties operating under a shared institutional structure but with potentially distinct organizational environments: Agriculture, Economics and Business, Education, Engineering, Philosophy, Health Sciences, Law, Science and Technology, Social and Political Sciences, and Tourism, Arts and Creative Industries.

Participants

The analysis included 150 lecturers and administrative staff, with 15 respondents represented from each faculty.

Five constructs were examined:

- Leadership Integrity (LI)
- Personal Planning (PP)
- Employee Commitment (EC)
- Green Strategic HRM (GSHRM)
- Sustainability Performance (SP)

Each construct contained 10 reflective indicators measured on a five-point Likert scale.

The relatively small number of respondents per faculty means that faculty-specific structural estimates should be treated as exploratory.

Analytical Procedure

The analysis follows three principal tiers.

Tier 1 (Descriptive analysis): Mean scores were calculated by faculty.

Tier 2 (Level heterogeneity): One-way ANOVA was used to test differences in means across faculties.

Tier 3 (Structural heterogeneity): The Chow test was applied to the three structural equations:

H0: $\beta_{Faculty\ 1} = \beta_{Faculty\ 2} = \ldots = \beta_{Faculty\ 10}$ (for each structural equation)

The null hypothesis was complete coefficient equality across faculties.

PLS-SEM and Measurement Considerations

The structural model underlying the empirical illustration was estimated using PLS-SEM.

PLS-SEM is particularly suitable for complex predictive models and has been widely used in GHRM research (Hair & Alamer, 2022).

Measurement quality should include assessment of:

- Indicator loadings
- Internal consistency reliability
- Convergent validity
- Discriminant validity
- Collinearity (VIF)

For discriminant validity, HTMT is preferred over reliance solely on Fornell–Larcker or cross-loading criteria (Henseler et al., 2015).

Multi-Group Extension

Where the objective is to identify specific heterogeneous structural paths, MICOM should precede PLS-MGA (Henseler et al., 2016).

For more than two groups, researchers should additionally address multiple-comparison problems and select appropriate omnibus or distance-based procedures (Cheah et al., 2023).

This is particularly important for the present 10-faculty setting.

RESULT AND DISCUSSION

Tier 1: Descriptive Heterogeneity

The five constructs showed meaningful variation across the 10 faculties, with reported means ranging from 3.86 to 4.28.

The Economics and Business and Health Sciences faculties generally exhibited relatively high scores, while Philosophy displayed comparatively lower values.

Table 1. Mean Scores by Construct (Pooled Across Faculties)

Construct	Mean
LI	3.88
PP	3.92
EC	3.90
GSHRM	3.86

The Philosophy faculty recorded the lowest mean scores among the five constructs, consistent with the overall pattern of comparatively lower values noted above.

These descriptive differences provide evidence of variation but do not establish statistical significance.

Tier 2: Level Heterogeneity

ANOVA results indicate statistically significant differences across faculties for all five constructs. The largest F statistic was observed for GSHRM ($F = 33.984$).

This establishes statistically significant level heterogeneity.

However, the result does not establish that the relationships among LI, PP, EC, GSHRM, and SP differ across faculties.

This is precisely where the distinction between levels and structures becomes analytically important.

Table 2. One-Way ANOVA Results by Construct

Construct	F	p
LI	33.792	<.001
PP	27.838	<.001
EC	26.245	<.001
GSHRM	33.984	<.001
SP	24.007	<.001

Note: df = (9, 140). All differences are statistically significant at $p < .001$.

Tier 3: Structural Heterogeneity

The coefficient-equality tests produced statistically significant results for all three equations. The findings indicate rejection of complete structural coefficient equality across faculties. Importantly, the F values should not be treated as directly comparable effect-size measures because the equations contain different numbers of restrictions.

Thus, the analysis does not establish that EC possesses "stronger" structural heterogeneity than GSHRM or SP.

Rather, the appropriate conclusion is:

Table 3. Omnibus Coefficient-Equality (Chow) Test Results

Equation	F	df	p
EC	5.319	(18,480)	<.001
GSHRM	2.503	(36,460)	<.001
SP	1.512	(45,450)	.021

Note: The three equations involve different numbers of restrictions and are therefore tested, not ranked, against one another.

This interpretation is more statistically defensible.

Theoretical Meaning of Level Heterogeneity

The ANOVA results demonstrate that faculty units occupy different positions on the five constructs.

This finding is consistent with the broader GHRM literature showing that green HR practices, employee attitudes, leadership, organizational culture, and sustainability outcomes can vary according to organizational context (Abbas et al., 2022; Al-Swidi et al., 2021; Joshi et al., 2023).

However, these mean differences should be interpreted as differences in organizational levels, not automatically as differences in causal mechanisms.

Why GSHRM's Largest ANOVA F Does Not Establish the Strongest Mechanism Difference

GSHRM produced the largest ANOVA F statistic.

This suggests substantial statistical differentiation in GSHRM levels across faculties. However, GSHRM level variation could result from differences in:

- Institutional resources
- Sustainability infrastructure
- Implementation maturity
- Leadership
- Organizational culture
- Exposure to sustainability programs

Therefore, a larger ANOVA F statistic reflects greater differentiation in construct levels, not necessarily a stronger or more heterogeneous underlying structural mechanism.

This is the first major implication of the framework.

Structural Heterogeneity as a Different Analytical Dimension

The structural tests demonstrate that complete coefficient equality cannot be assumed for EC, GSHRM, and SP.

This finding is important because contemporary GHRM literature increasingly identifies mediating and contextual mechanisms through which GHRM influences sustainability outcomes.

For example, green culture, green absorptive capacity, green innovation, and employee empowerment have all been identified as mechanisms linking GHRM to organizational and employee outcomes (Hooi, 2022; Khan & Muktar, 2024; Munawar et al., 2022; Sarmad et al., 2023).

The present study extends this logic by asking whether such structural relationships can be assumed to be homogeneous across organizational units.

The Importance of Not Overinterpreting the Chow Test

A significant omnibus Chow test does not identify the specific heterogeneous path.

For example, the path coefficient β(EC $\rightarrow$ GSHRM) may differ across faculties, but the omnibus test alone cannot establish that this particular coefficient is responsible for the result.

Similarly, the test cannot establish that every faculty differs from every other faculty. Consequently, structural heterogeneity should be interpreted in stages:

- Omnibus coefficient-equality testing (Chow test) — establishes whether complete coefficient equality can be rejected
- Path-level multigroup comparison (PLS-MGA) — identifies which specific path(s) differ
- Faculty-pair comparison — identifies which organizational units are responsible for the difference

This is why PLS-MGA becomes a logical subsequent procedure.

From Mean Differences to Organizational Mechanisms

The distinction provides a more precise organizational interpretation.

Level heterogeneity asks: Where are organizational units different?

Structural heterogeneity asks: How do relationships operate differently?

This distinction is particularly important in decentralized organizations such as universities. Two faculties may have different levels of GSHRM because they have different resources.

But if the same relationship between Employee Commitment and GSHRM operates similarly across both faculties, the appropriate explanation is level differentiation rather than structural differentiation.

Conversely, if two faculties have similar GSHRM means but different EC → GSHRM coefficients, then structural heterogeneity exists despite limited mean-level differences.

CONCLUSION

The findings of this study demonstrated that organizational heterogeneity in Green Human Resource Management (GHRM) research could not be adequately assessed through mean-level comparisons alone. The three-tier analytical approach applied at Universidade Nacional Timor Lorosa'e (UNTL) revealed statistically significant level heterogeneity across all five constructs. One-way analysis of variance (ANOVA) results confirmed significant differences in mean scores across faculties for Leadership Integrity, Personal Planning, Employee Commitment, Green Strategic Human Resource Management (GSHRM), and Sustainability Performance. Furthermore, the omnibus coefficient-equality tests yielded statistically significant results for all three structural equations, indicating that the null hypothesis of complete structural coefficient equality across faculties was rejected. This distinction has important theoretical implications: the largest ANOVA F-statistic, observed for GSHRM, indicated greater differentiation in construct levels rather than stronger heterogeneity in the underlying structural relationships. These findings highlighted the importance of distinguishing the magnitude of mean differences from the extent of structural variation. The study also demonstrated that statistically significant omnibus tests did not identify which specific structural paths differed or which faculty pairs contributed to the observed heterogeneity, emphasizing the need for a sequential analytical approach progressing from omnibus testing to path-specific multigroup comparisons and pairwise faculty analyses. Consequently, the findings supported the conceptual distinction between level heterogeneity, which concerns differences in construct levels across organizational units, and structural heterogeneity, which concerns differences in relationships among constructs. This distinction represents an important methodological consideration for GHRM research conducted in decentralized organizational settings, particularly higher education institutions.

Future research should extend the proposed analytical framework in several directions. First, subsequent studies should move beyond omnibus Chow tests by conducting path-specific multigroup analysis using partial least squares multigroup analysis (PLS-MGA), preceded by measurement invariance assessment through the measurement invariance of composite models (MICOM) procedure. This approach would help identify the specific structural paths and faculty pairs contributing to the observed heterogeneity. Second, because the present study included only 15 respondents per faculty, future investigations should employ larger samples with adequate representation across groups to improve statistical power and the precision and stability of faculty-

specific structural estimates. Accordingly, the present findings should be interpreted cautiously, particularly regarding subgroup-level structural differences. Third, future studies should address the multiple-comparison issues associated with analyses involving more than two groups by applying appropriate omnibus testing procedures and adjustments for multiple pairwise comparisons. Fourth, longitudinal research designs could examine whether structural heterogeneity remained stable over time or changed alongside developments in sustainability infrastructure, leadership practices, and the maturity of GHRM implementation across organizational units. Finally, comparative investigations involving multiple universities and national contexts would help establish whether the distinction between level and structural heterogeneity observed at UNTL extended to other higher education systems. Such investigations could strengthen the external validity of the proposed three-tier analytical approach and enhance its applicability to evidence-based GHRM policies and organizational sustainability practices.

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