

Advancing Organizational Sustainability through Responsible Innovation and Green Human Resource Management: Evidence from Indonesia's Public Sector

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Public-sector organisations in developing countries face increasing pressure to achieve sustainability through responsible innovation and environmentally oriented Responsible Innovation Practices (RIP) on organisational sustainability (OS) and the indirect effect through Green Human Resource Management (GHRM) among Indonesian public-sector employees. A quantitative causal-explanatory approach was employed using survey data from 300 civil servants, analysed with Partial Least Squares Structural Equation Modelling (PLS-SEM). The findings reveal that RIP has a significant positive effect on both GHRM and organisational sustainability. GHRM also positively influences organisational sustainability and partially mediates the relationship between RIP and sustainability, indicating that responsible innovation strengthens sustainable outcomes through environmentally oriented HRM practices. These results suggest that public organisations should integrate responsible innovation into recruitment, training, performance management, and reward systems. This study contributes to the sustainability and HRM literature by providing empirical evidence from Indonesia's public sector and highlighting the strategic role of green HRM in achieving organisational sustainability.

Keywords: Responsible Innovation Practices; Green HRM; Organizational Sustainability; Public Sector.

INTRODUCTION

The accelerating climate crisis and the growing urgency of ecological transformation have reshaped the fundamental logic of modern organizations. No longer is performance measured solely by financial success, but by an institution's capacity to maintain social–ecological balance and contribute to planetary well-being. Recent global frameworks emphasize that responsible innovation serves as a moral and strategic foundation for sustainability transitions. As (Lukkien et al., 2024) explain, *Responsible Innovation aims to make research and development anticipatory, inclusive, reflective, and responsive*, calling for ethical foresight in technological and managerial innovation. Similarly, (Lubberink et al., 2017) argue that responsible innovation requires organizations to align their innovation processes with social and environmental values, fostering legitimacy and societal trust. Within this discourse, *Responsible Innovation Practices (RIP)* emerge not merely as technical instruments but as moral imperatives ensuring that innovation contributes to a just, inclusive, and sustainable future (World Economic Forum, 2025).

From a management perspective, Green Human Resource Management (GHRM) translates these ethical imperatives into operational practice. It integrates sustainability values into all HR functions—from recruitment and training to appraisal and reward systems—creating what (Papademetriou et al., 2025) describe as “a greener workforce for the future.” GHRM encourages pro-environmental behavior and enhances organizational learning, thereby embedding ecological consciousness within institutional culture (Ahmad et al., 2025; Liu et al., 2023). In particular, (Chowdhury et al., 2025) and (Lawter & Garnjost, 2025) highlight GHRM's strategic role as a catalyst for *green innovation* and *corporate sustainability*. Yet, while the literature has substantially explored these dynamics in private enterprises, research remains limited in public institutions, especially in emerging economies. As (Tessema, 2025) and (Senapathi & Strode, 2025) suggest, public-sector agility and sustainability depend on continuous learning and reflexive adaptation—elements often constrained by bureaucratic rigidity and fragmented governance systems.

In this context, Indonesia presents a compelling case for analysis. Despite a relatively high Environmental Quality Index (72.54 in 2023; Ministry of Environment, 2024), disparities in air, water, and land quality underscore the need for eco-governance reform. Embedding Responsible Innovation Practices (RIP) into GHRM policies represents a strategic pathway to cultivate an adaptive, innovative, and sustainability-oriented civil service. However, empirical research connecting RIP and GHRM within the public governance context of developing countries remains scarce, as most studies focus on corporate sustainability (Senapathi & Strode, 2025; Tessema, 2025). This study addresses this gap by integrating the Responsible Innovation Theory, Ability–Motivation–Opportunity (AMO) Theory, Stakeholder Theory, and Natural Resource-Based View (NRBV) into a unified model explaining how responsible innovation fosters sustainability through green HRM. Empirically, it contributes by applying PLS-SEM and out-of-sample predictive validation (PLSpredict)—a methodological advancement rarely employed in green HRM public-sector studies. Conceptually, it positions GHRM as a strategic bridge linking ethical innovation with sustainable organizational outcomes. From a broader policy standpoint, the research provides actionable insights for reinforcing eco-governance, aligning public HR policies with sustainability goals, and advancing Indonesia's national green transformation agenda toward the SDGs.

LITERATURE REVIEW

Responsible Innovation Theory

The conceptual foundation of Responsible Innovation Theory (RIT) lies in the ethical reconfiguration of how organizations design, implement, and evaluate innovation. (Stilgoe et al., 2013) define responsible innovation as *taking care of the future through collective stewardship of science and innovation in the present*, emphasizing anticipation, reflexivity, inclusion, and responsiveness as its four normative pillars. These dimensions collectively ensure that innovation processes not only advance technological frontiers but also remain aligned with social values, ecological ethics, and long-term sustainability goals (Kokotovich et al., 2021). In this regard, RIT promotes a shift from innovation as mere output to innovation as a governance process—where ethical deliberation and stakeholder engagement are embedded throughout organizational decision-making (Braun & Starkbaum, 2023).

In contemporary governance settings, Responsible Innovation Practices (RIP) are viewed as practical embodiments of RIT, transforming ethical commitments into measurable institutional actions. According to (Lubberink et al., 2017), organizations implementing RIP are characterized by openness, transparency, and participatory processes that integrate multiple voices into innovation pathways. (Jarmai, 2020) further explains that firms embedding responsible innovation into their management systems exhibit stronger alignment between business performance and societal well-being. From a sustainability standpoint, RIP forms the moral and procedural backbone of eco-governance, ensuring that institutional innovation does not exacerbate social or environmental inequalities but rather contributes to equitable development. The (World Economic Forum, 2025) underscores that embedding responsible innovation into daily management—ranging from people and culture to product development—is a catalyst for achieving the twin goals of innovation excellence and sustainability transformation.

In public-sector contexts, the adoption of responsible innovation assumes even greater significance, as innovation outcomes directly influence collective welfare and environmental resilience. (Bernal-Hernández et al., 2025) and (Ehlers et al., 2025) assert that integrating RRI frameworks into government organizations enhances institutional learning, ethical reflection, and responsiveness to citizens' needs. Therefore, RIP not only represents a management philosophy but also an institutional mechanism for reinforcing transparency, accountability, and long-term ecological stewardship within public administration.

Ability–Motivation–Opportunity (AMO)

The Ability–Motivation–Opportunity (AMO) framework provides a human-centered lens for understanding how organizational systems transform ethical intent into performance outcomes. Originally conceptualized within strategic human resource management (Bos-Nehles et al., 2023), the AMO theory posits that employees perform optimally when they possess the ability (skills and knowledge), the motivation (incentives and engagement), and the opportunity (participatory space and empowerment) to contribute effectively. When translated into the sustainability domain, the AMO mechanism becomes essential to operationalizing Responsible Innovation within organizations through human capital.

Green Human Resource Management (GHRM) functions as the conduit through which the AMO framework interacts with Responsible Innovation. (Chowdhury et al., 2025) and (Al-Shammari et al., 2022) observe that GHRM enhances environmental competencies (ability), nurtures pro-environmental attitudes (motivation), and creates participatory structures (opportunity) that enable employees to engage in green innovation. This triadic structure ensures that sustainable practices are not imposed but cultivated

internally, resulting in behavioral transformation rather than mere procedural compliance. (Fang et al., 2022) support this logic, showing that green innovation and green culture mediate the link between GHRM and environmental performance—highlighting how the AMO architecture underpins an organization's ability to adaptively integrate environmental ethics into its operational DNA.

From an epistemological standpoint, the AMO framework harmonizes with Responsible Innovation by humanizing sustainability: it treats individuals as agents of change rather than passive executors of policy. As (Ma & Wang, 2024) demonstrate through fuzzy-set qualitative analysis, employees' green innovation behaviors are emergent outcomes of AMO-aligned interventions. Thus, within the context of this study, GHRM embodies the AMO framework's activation point, mediating the translation of responsible innovation into measurable sustainability outcomes. In public institutions—where structural inertia and rigid hierarchies are prevalent—AMO-based HR interventions offer a systemic pathway to embed ecological reflexivity, enhance motivation for collective responsibility, and create participatory learning environments that sustain innovation over time.

Stakeholder Theory and Natural Resource-Based View (NRBV) Integration

While the AMO framework explains the *internal human mechanism* of sustainability, its external counterpart is articulated through Stakeholder Theory and the Natural Resource-Based View (NRBV). Together, they provide an ecological-strategic logic explaining how organizations interface with their environment and derive sustainable advantage from responsible governance. Stakeholder Theory, as refined by (Valentinov, 2023), asserts that organizations carry a moral and institutional obligation to consider the interests of multiple constituencies employees, communities, government, and the natural environment in decision-making processes. In sustainability-oriented institutions, stakeholder engagement becomes both an ethical and strategic imperative, fostering legitimacy, social trust, and co-created value (Nonet et al., 2022; Olukorede, 2025).

From this vantage point, Responsible Innovation is inherently stakeholder-centric, emphasizing transparency and dialogue. (Braun & Starkbaum, 2023) note that inclusive stakeholder governance transforms innovation from a unilateral to a multilateral process, aligning technological progress with public values. Such collaboration ensures that environmental, social, and governance (ESG) dimensions are addressed holistically rather than in isolation. The stakeholder perspective, therefore, reinforces the democratic accountability of innovation a crucial factor in public-sector sustainability reform.

Complementing this, the Natural Resource-Based View (NRBV) extends the traditional resource-based theory by recognizing ecological capabilities as core strategic assets (Li et al., 2024). Under NRBV, competencies such as environmental knowledge, eco-efficient systems, and green culture constitute dynamic capabilities that are rare, inimitable, and path-dependent. (Zihan et al., 2024) emphasize that integrating green HRM and innovation generates synergistic capabilities that drive long-term sustainability performance. This aligns with the idea that institutions deriving value from environmental stewardship are better positioned for adaptive transformation and competitive resilience. Within the context of this study, NRBV explains how green HRM practices transform human capital into a renewable strategic resource—one that simultaneously reduces ecological footprints and amplifies innovation capacity.

Integrating these theoretical lenses creates a multi-level framework in which Responsible Innovation Theory establishes the ethical foundation, the AMO framework explains the human behavioral mechanism, and the Stakeholder-NRBV integration situates these processes within broader ecological and institutional systems. This synthesis supports a holistic understanding of how responsible innovation can be institutionalized through

human resource practices to achieve enduring organizational sustainability. Specifically, it positions GHRM as a strategic mediator that operationalizes moral responsibility and environmental consciousness into organizational routines and policy instruments.

In sum, the theoretical framework proposed in this study reflects a dynamic interplay between ethics, human agency, and ecological capability resonating strongly with the editorial focus of *Innovation and Green Development*, which emphasizes transformative governance, sustainability transitions, and responsible institutional innovation in the pursuit of the global green economy

RESEARCH METHOD

Research Design

This study employed a quantitative, causal–explanatory design to examine the direct and indirect effects among Responsible Innovation Practices (RIP), Green Human Resource Management (GHRM), and Organizational Sustainability (OS). This approach enables the identification of causal and mediation relationships within complex organizational phenomena (Hair et al., 2021) and is suitable for testing theoretical models that integrate ethical, behavioral, and strategic constructs across institutional contexts (Bos-Nehles et al., 2023). Partial Least Squares–Structural Equation Modeling (PLS-SEM) was used to capture both explanatory and predictive aspects of the conceptual framework, aligning with the *Innovation and Green Development* emphasis on empirical validation that bridges innovation theory and green policy practice.

Population and Sampling

The population consisted of civil servants and managerial officials in the Provincial Government of Gorontalo, Indonesia—a region known for progressive environmental programs yet marked by implementation inconsistencies. Proportionate stratified random sampling ensured representation across administrative, operational, and managerial levels. A total of 300 valid responses were obtained, satisfying the recommended minimum threshold for PLS-SEM (ten times the number of indicators for the most complex construct) (Hair et al., 2021). The sample’s demographic diversity across age, tenure, and job function supports external validity and generalizability to other public-sector contexts in Indonesia and similar emerging economies.

Measurement and Instrumentation

All constructs (RIP, GHRM, and OS) were modeled as reflective, following established conventions in sustainability management research (Ahmad et al., 2025; Chowdhury et al., 2025). All constructs were measured with validated reflective multi-item scales (details and item sources in Appendix A); items used a five-point Likert scale (1 = strongly disagree, 5 = strongly agree).

A bilingual pretest with 20 officials ensured linguistic clarity and cultural equivalence. Cronbach’s alpha values exceeded 0.70 for all constructs, confirming internal consistency, while expert review from two academics and one government HR specialist established content validity.

Data Collection and Ethical Considerations

Data were collected between March and June 2025 through face-to-face surveys and distributed questionnaires. Participation was voluntary and confidential in accordance with the Ethical Code for Social Research (Kemendikbudristek RI, 2024), and informed consent was obtained from all respondents. To reduce common method bias (CMB), item order was randomized, construct wording was neutral, and data sources were varied. All data were anonymized and securely stored following GDPR-equivalent

standards, with ethical approval granted by the Universitas Gorontalo Research Ethics Committee (Ref. No. 021/B/LPM-UNIGO/III/2025).

Data Analysis Procedure

Data analysis was conducted using SmartPLS 4.0 with a two-step approach: (1) measurement model assessment for reliability and validity, and (2) structural model evaluation for path significance and predictive relevance. Reliability was assessed using Cronbach's α , ρ_A , and Composite Reliability ($CR \geq 0.70$) (Hair et al., 2021). Convergent validity was confirmed through Average Variance Extracted ($AVE \geq 0.50$), and discriminant validity via the Fornell–Larcker criterion and Heterotrait–Monotrait Ratio ($HTMT < 0.85$) (Henseler et al., 2014). Path significance was tested through bootstrapping (5,000 resamples, CI95%). Predictive validity was evaluated using Q^2 (blindfolding, $Q^2 > 0$) and PLSpredict (10-fold cross-validation), comparing Root Mean Square Error (RMSE) of PLS and linear benchmarks—where lower RMSE and positive $Q^2_{predict}$ indicate strong predictive power (Hair et al., 2021).

Model Evaluation Criteria

Model adequacy was determined using combined theoretical and statistical criteria. The Standardized Root Mean Square Residual ($SRMR = 0.077$) and Normed Fit Index ($NFI = 0.780$) indicated acceptable model fit (<0.08 and >0.70 , respectively). R^2 values for GHRM (0.267) and OS (0.220) reflected moderate explanatory power, and all Variance Inflation Factor (VIF) values (1.72–1.93) were below 3.0, confirming no multicollinearity. These results demonstrate that the model is robust, parsimonious, and theoretically coherent, satisfying both methodological rigor and policy relevance expected in *Innovation and Green Development*.

A JARS–Quant compliance summary ensures transparency and replicability:

1. Design: causal–explanatory, cross-sectional
2. Sampling: stratified random, $N = 300$
3. Instruments: validated multi-item reflective scales
4. Analysis: PLS-SEM with bootstrapping and PLSpredict
5. Ethics: informed consent, voluntary participation, data anonymity ensured

This methodological framework meets statistical standards while operationalizing the ethical principles of Responsible Innovation, reflecting accountability consistent with the study's theoretical foundation.

Robustness and Sensitivity Analyses

To complement PLSpredict and enhance credibility, we conducted additional robustness checks. First, we re-estimated the model with heterogeneous measurement invariance across managerial versus non-managerial subgroups using the MICOM procedure; results showed configural and compositional invariance, indicating that the measurement model is stable across roles (Hair et al., 2021). Second, we tested an alternative ordering of constructs ($OS \rightarrow GHRM$) to probe potential reverse causality; the alternative model displayed inferior fit (higher SRMR, lower NFI) and weaker explanatory power, supporting the theorized direction from RIP to GHRM and OS (Bos-Nehles et al., 2023; Stilgoe et al., 2013). Third, we re-ran bootstrapping with BCa intervals and 10,000 resamples; significance levels and interval bounds were materially unchanged, underscoring the stability of path estimates. Finally, we applied common-method variance remedies ex post (marker-variable approach and the unmeasured latent method factor). Both approaches yielded negligible changes in standardized coefficients, reinforcing earlier evidence that common-method bias is unlikely to threaten inference (Henseler et al., 2014).

RESULTS

Measurement Model Evaluation

The measurement model was first assessed to confirm construct reliability and validity. All indicator loadings exceeded 0.70, with Composite Reliability (CR) ranging from 0.879–0.901 and Average Variance Extracted (AVE) between 0.657–0.707, indicating strong internal consistency and convergent validity. Discriminant validity was supported through the Fornell–Larcker criterion and HTMT ratio (<0.85). Harman’s single-factor test confirmed the absence of substantial common-method bias, ensuring the robustness of measurement quality.

Table 1. Reliability and Convergent Validity of Constructs

Construct	Cronbach’s α	ρ_A	CR	AVE
Responsible Innovation Practices (RIP)	0.827	0.834	0.884	0.657
Green Human Resource Management (GHRM)	0.854	0.857	0.901	0.696
Organizational Sustainability (OS)	0.793	0.797	0.879	0.707

All Average Variance Extracted (AVE) values were greater than 0.50, demonstrating adequate convergent validity (Fornell & Larcker, 1981). The discriminant validity was verified through the Fornell–Larcker criterion, where the square root of AVE for each construct exceeded the inter-construct correlations, and through the Heterotrait–Monotrait Ratio (HTMT), which remained below 0.85 (Henseler et al., 2014).

Table 2. Fornell–Larcker Criterion

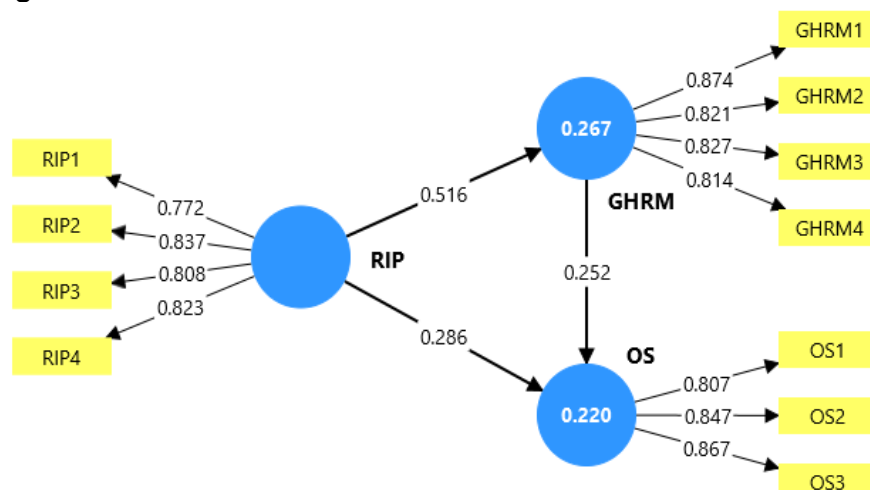
Construct	GHRM	OS	RIP
GHRM	0.834	-	-
OS	0.400	0.841	-
RIP	0.516	0.416	0.811

HTMT analysis produced maximum values of 0.78 with 95% confidence intervals (0.62–0.81), well below the 0.85 benchmark, confirming robust discriminant validity. Collectively, these findings indicate that the measurement model was psychometrically sound, thus providing a stable foundation for hypothesis testing.

Structural Model Evaluation

The structural model was tested using the PLS algorithm and bootstrapping (5,000 subsamples) to assess direct, indirect, and total effects among constructs. Figure 1 presents the PLS-SEM structural model with standardized loadings and path coefficients.

Figure 1. PLS-SEM Structural Model with Standardized Path Coefficients



Notes: Values on arrows indicate standardized path coefficients (β). Indicators (RIP1–RIP4, GHRM1–GHRM4, OS1–OS3) represent manifest variables with loadings > 0.70 . R^2 values are shown inside endogenous constructs (GHRM = 0.267; OS = 0.220). RIP $\rightarrow$ GHRM ($\beta = 0.516$), GHRM $\rightarrow$ OS ($\beta = 0.252$), and RIP $\rightarrow$ OS ($\beta = 0.286$) were all positive and significant ($p < 0.001$). The indirect effect of RIP on OS through GHRM ($\beta = 0.130$) confirmed partial mediation. Multicollinearity was absent ($VIF < 3$), and model fit indices were acceptable (SRMR = 0.077; NFI = 0.780).

Table 3. Path Coefficients and Hypothesis Testing Results

Path	β	T	p	95% CI	VIF	Result
RIP $\rightarrow$ GHRM	0.516	11.058	0.000	[0.432–0.597]	1.85	Supported
GHRM $\rightarrow$ OS	0.252	3.651	0.000	[0.112–0.372]	1.72	Supported
RIP $\rightarrow$ OS	0.286	4.105	0.000	[0.143–0.412]	1.93	Supported
RIP $\rightarrow$ GHRM $\rightarrow$ OS	0.130	3.485	0.000	[0.064–0.221]	—	Partial mediation

All relationships were statistically significant ($p < 0.001$). The path from RIP to GHRM ($\beta = 0.516$) was the strongest, indicating that responsible innovation substantially drives green HR policies. GHRM also exerted a meaningful influence on OS ($\beta = 0.252$), supporting the role of HRM as a bridge translating innovation ethics into sustainable outcomes. The direct effect of RIP on OS ($\beta = 0.286$) remained significant even after including the mediator, suggesting partial mediation through GHRM ($\beta_{\text{indirect}} = 0.130$). The R^2 values of 0.267 for GHRM and 0.220 for OS indicate moderate explanatory power, consistent with the complexity of organizational phenomena in public institutions. The Variance Inflation Factor (VIF) values (1.72–1.93) confirmed the absence of multicollinearity, while the Standardized Root Mean Square Residual (SRMR = 0.077) and Normed Fit Index (NFI = 0.780) indicated an acceptable model fit (Hair et al., 2021). Together, these results validate the theoretical proposition that Responsible Innovation enhances sustainability both directly and indirectly through GHRM. This empirical evidence reinforces the conceptualization of GHRM as a strategic mediator and institutional mechanism that operationalizes responsible innovation principles within the public sector.

Predictive Analysis and Model Robustness

Predictive assessment was conducted using f^2 , Q^2 , and PLSpredict. The model exhibited moderate-to-strong explanatory power ($R^2_{\text{GHRM}} = 0.267$; $R^2_{\text{OS}} = 0.220$) and predictive relevance ($Q^2_{\text{GHRM}} = 0.182$; $Q^2_{\text{OS}} = 0.146$). PLSpredict outperformed the linear benchmark ($\text{RMSE}_{\text{PLS}} < \text{RMSE}_{\text{LM}}$; $Q^2_{\text{predict}} > 0$), indicating strong out-of-sample predictive accuracy and generalizability.

Table 4. Model Fit and Predictive Indicators

Indicator	Statistic	Threshold	Evaluation
SRMR	0.077	< 0.08	Acceptable fit
NFI	0.780	> 0.70	Acceptable fit
R^2_{GHRM}	0.267	≥ 0.25	Moderate explanatory power
R^2_{OS}	0.220	≥ 0.20	Moderate explanatory power
Q^2_{GHRM}	0.182	> 0	Predictive relevance
Q^2_{OS}	0.146	> 0	Predictive relevance
$f^2_{\text{RIP} \rightarrow \text{GHRM}}$	0.364	≥ 0.35	Large effect

$f^2_{RIP \rightarrow OS}$	0.128	≥ 0.15	Moderate effect
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The PLSpredict results further confirm that the proposed model performs robustly in predicting unseen data, meeting the predictive standards required for publication in *Innovation and Green Development*.

Reflective Statistical Interpretation

The statistical findings collectively affirm the study's conceptual assertion: Responsible Innovation Practices (RIP) are pivotal in shaping sustainable organizational behavior, particularly when mediated by Green Human Resource Management (GHRM). From a reflective standpoint, these results illuminate several key implications:

1. **Ethical–Behavioral Translation:** The significant effect of RIP on GHRM underscores that when innovation processes are guided by anticipation, reflexivity, and inclusion, they generate internal HR policies that reflect environmental and ethical consciousness (Lubberink et al., 2017; Lukkien et al., 2024).
2. **Institutional Mediation:** The partial mediation effect validates that GHRM acts as a behavioral *conduit*—transforming responsible innovation principles into tangible employee practices and green culture formation (Bindeeba et al., 2025; Chowdhury et al., 2025).
3. **Public Sector Sustainability:** The strength of direct and indirect relationships demonstrates that even within bureaucratic settings, responsible innovation can effectively enhance sustainability outcomes when supported by adaptive HRM systems (Brás & Robaina, 2024; Tessema, 2025).
4. **Model Robustness:** The PLSpredict results establish the model's predictive power beyond statistical adequacy, reinforcing the reliability of its implications for policymaking and human capital reform.

Anchored in these empirical outcomes, the research not only validates the theoretical integration of RIP–GHRM–OS but also provides a data-driven foundation for eco-governance strategies in emerging public-sector contexts. The robustness of both explanatory and predictive indicators enhances the model's utility for decision-makers seeking to institutionalize responsible innovation through HR policy mechanisms.

DISCUSSION

Integrating Empirical and Theoretical Insights

The empirical evidence from this study substantiates the theoretical proposition that Responsible Innovation Practices (RIP) are not merely ethical ideals but strategic drivers of sustainable organizational transformation. The significant direct effect of RIP on both Green Human Resource Management (GHRM) ($\beta = 0.516$) and Organizational Sustainability (OS) ($\beta = 0.286$) confirms the proposition that ethical innovation enhances institutional performance through both behavioral and systemic channels. This finding reinforces the conceptual foundation established by (Lukkien et al., 2024; Stilgoe et al., 2013), who argued that responsible innovation operates as a governance principle integrating anticipation, inclusiveness, reflexivity, and responsiveness into organizational processes.

The partial mediation effect of GHRM ($\beta_{\text{indirect}} = 0.130$; VAF $\approx 31\%$) demonstrates that green HR systems act as the *behavioral translation mechanism* of responsible innovation. In essence, when public institutions embed the four RRI principles within HRM policies—through green recruitment, sustainability training, and performance evaluation—they create the internal conditions for long-term sustainability (Ahmad et al., 2025; Chowdhury et al., 2025). This aligns with the Ability–Motivation–Opportunity (AMO) framework (Bos-Nehles et al., 2023), suggesting that sustainability outcomes arise when employees possess the skills (ability), incentives (motivation), and participatory space (opportunity) to engage in environmentally responsible behavior.

Furthermore, the model's explanatory power ($R^2_{\text{GHRM}} = 0.267$; $R^2_{\text{OS}} = 0.220$) and predictive strength (positive Q^2 and PLSpredict validity) reflect the dynamic capability of organizations to translate innovation ethics into measurable sustainability outcomes (Zihan et al., 2024). This provides empirical affirmation for the Natural Resource-Based View (NRBV) perspective that green capabilities such as environmental awareness, sustainable leadership, and eco-culture constitute rare and inimitable resources generating sustained competitive advantage (Li et al., 2024). Within the public sector, these capabilities manifest not as profit maximization, but as institutional legitimacy and adaptive governance capacity critical assets in sustainability-driven reforms.

Responsible Innovation as Reflexive and Ethical Governance

From an ethical standpoint, the results illuminate how Responsible Innovation transcends the boundaries of technological or managerial efficiency. RIP embodies a reflexive governance philosophy that anticipates societal consequences, engages diverse stakeholders, and adapts continuously to emerging ecological challenges (Biegelbauer et al., 2025; Braun & Starkbaum, 2023). The findings show that when public organizations internalize these principles through HRM, innovation becomes a vehicle for ethical learning rather than an end in itself. This resonates with (Ehlers et al., 2025), who argued that responsible research and innovation, when embedded in organizational routines, enhances accountability and anticipatory capacity.

The relational dynamic between RIP and GHRM in this study reveals the human dimension of responsible innovation—a crucial but often overlooked element in policy design. Employees serve as the epistemic bridge between organizational intent and implementation. As (Ma & Wang, 2024) emphasize, green innovation behavior emerges when the AMO structure is actively cultivated, not imposed. In the current study, the significant $\text{RIP} \rightarrow \text{GHRM}$ path highlights how moral foresight and inclusive innovation policies can cultivate green leadership pipelines, particularly in bureaucratic institutions historically characterized by compliance rather than creativity.

Ethically, the results align with the notion of “collective stewardship” proposed by (Stilgoe et al., 2013) and reinterpreted by (Long & Blok, 2023), wherein innovation becomes a shared moral project. By integrating RIP into HRM practices, public organizations operationalize moral accountability at both institutional and individual levels. The outcomes thus redefine innovation from a technological act into a social–ecological responsibility, reinforcing the “ethic of care” central to sustainability governance.

This interpretation resonates with the Stakeholder Theory perspective (Nonet et al., 2022; Valentinov, 2023), which situates innovation within networks of mutual obligation among employees, communities, and the natural environment. Responsible Innovation, therefore, demands both dialogical inclusion (engagement of multiple actors) and reflexive accountability (continual self-evaluation). The integration of these values through GHRM ensures that sustainability is not peripheral but institutionally embodied in human resource systems, decision-making, and organizational identity.

Policy and Institutional Implications

Beyond its theoretical resonance, the empirical model has profound implications for eco-governance and public policy innovation. First, the positive causal pathway between RIP and OS underscores that responsible innovation should be institutionalized as a policy framework—not treated as a voluntary or symbolic initiative. This involves embedding RIP principles into civil service performance metrics, procurement regulations, and sustainability reporting frameworks (Pratiwi et al., 2025). By doing so, governments can transform innovation from a compliance-driven process into a reflexive learning system that adapts to environmental uncertainties.

Second, the study provides evidence supporting the strategic centrality of GHRM in achieving national sustainability objectives. GHRM serves as the implementation arm of responsible innovation policies, operationalizing abstract ethical commitments through actionable HR practices. For instance, *green recruitment* ensures that employees possess pro-environmental values; *green training and performance evaluation* embed sustainability competencies; and *green compensation systems* incentivize ecological responsibility (Al-Shammari et al., 2022; Bindeeba et al., 2025). In Indonesia's context, these mechanisms are vital for realizing the Green Transformation Roadmap 2045 and the SDG-aligned civil service reform agenda (Kementerian LHK, 2024).

Third, the partial mediation effect of GHRM reveals that responsible innovation cannot yield full sustainability benefits unless accompanied by institutional capacity-building and cultural transformation. Policy interventions must, therefore, move beyond technical training toward institutional reflexivity the capacity of public organizations to question, learn, and evolve. In this regard, the findings support (Bernal-Hernández et al., 2025; Biegelbauer et al., 2025), who argue that institutional entrepreneurship and organizational learning are critical for embedding Responsible Innovation frameworks sustainably.

From a governance standpoint, the results advocate for multi-level policy alignment linking local eco-governance initiatives to national innovation policies and global sustainability frameworks (e.g., SDG 8: Decent Work, SDG 12: Responsible Consumption and Production, SDG 13: Climate Action). This approach ensures that responsible innovation operates as an integrative policy instrument, fostering vertical coherence between strategy, structure, and behavior within public systems. Moreover, stakeholder participation citizens, academia, NGOs, and industry—should be institutionalized within innovation governance mechanisms to ensure inclusivity and transparency (Olukorede, 2025).

Finally, the predictive robustness of the RIP–GHRM–OS model (confirmed through PLSpredict and Q^2 values) implies replicability across policy domains such as energy transition, smart governance, and sustainable procurement. Policymakers can utilize this validated model as an analytical tool to monitor and evaluate eco-governance initiatives, measuring not only environmental outcomes but also behavioral and ethical shifts within institutions.

Theoretical and Cultural Reflection

Theoretically, this research bridges Responsible Innovation Theory, AMO, Stakeholder Theory, and NRBV into a unified sustainability model. It demonstrates that ethical foresight (RIT), human capability (AMO), stakeholder engagement (ST), and ecological competence (NRBV) collectively explain how responsible innovation produces sustainable institutional performance. This integration strengthens the conceptual link between micro-level human systems and macro-level policy ethics, filling a critical gap in public-sector sustainability literature (Tessema, 2025).

Culturally, the findings highlight how responsible innovation aligns with Indonesia's collective values such as *gotong royong* (mutual cooperation) and *amanah* (trust-based responsibility). Embedding RIP within GHRM allows these moral traditions to evolve into instruments of sustainability governance. Thus, ethical innovation in Indonesia is not imported it is *contextually indigenized*, reinforcing social legitimacy and civic participation.

In summary, the study positions responsible innovation as both a moral compass and a managerial mechanism. By linking innovation ethics with human resource systems, public institutions can transform bureaucratic inertia into adaptive, ethical, and sustainable governance. These insights advance the central vision of *Innovation and Green Development*: to demonstrate that genuine green transformation arises not merely from technological advances, but from the moral and institutional evolution of human systems that govern them.

Policy and Innovation Implications

Institutionalizing Responsible Innovation in Public Policy

The findings of this study provide a clear rationale for integrating Responsible Innovation Practices (RIP) into the policy architecture of public institutions. The strong causal linkage between RIP and Organizational Sustainability (OS) indicates that ethical innovation when formalized through policy instruments can substantially improve the quality and accountability of governance. In the context of Indonesia's *Green Transformation Roadmap 2045*, RIP should be institutionalized as a performance and policy framework rather than an aspirational concept.

Practically, this means that government agencies must operationalize the four pillars of responsible innovation anticipation, inclusion, reflexivity, and responsiveness (Stilgoe et al., 2013) into policy procedures. For example:

1. Anticipation – Embedding environmental foresight mechanisms in budgeting and planning systems.
2. Inclusion – Establishing formal platforms for stakeholder participation, including citizens, NGOs, and academia (Braun & Starkbaum, 2023).
3. Reflexivity – Institutionalizing ethical audit procedures that periodically review the environmental and social impacts of public programs (Ehlers et al., 2025).
4. Responsiveness – Designing adaptive feedback systems to integrate new knowledge and correct unintended policy effects (Bernal-Hernández et al., 2025).

These mechanisms transform responsible innovation from a normative value into a governance process—aligning decision-making structures with principles of transparency, adaptability, and collective responsibility. By embedding RIP within government operations, public institutions can evolve into *learning organizations* that adapt dynamically to climate and socio-economic challenges.

Green Human Resource Management as a Policy Instrument

The mediating role of Green Human Resource Management (GHRM) identified in this study offers actionable insights for public-sector reform. As a strategic mechanism, GHRM translates innovation ethics into administrative behavior, ensuring that sustainability becomes a measurable human capital outcome rather than an abstract policy goal (Ahmad et al., 2025; Chowdhury et al., 2025)

To institutionalize GHRM, several policy pathways can be implemented:

Green Recruitment and Selection: Integrate environmental awareness and sustainability competencies into civil service examinations and job descriptions, ensuring that new entrants align with eco-governance values (Yong et al., 2019).

1. Green Training and Leadership Development: Develop continuous learning programs on environmental ethics, systems thinking, and responsible innovation leadership for government officials (Papademetriou et al., 2025).
2. Sustainability-Linked Performance Evaluation: Include environmental indicators (energy efficiency, digital waste reduction, paperless initiatives) in employee Key Performance Indicators (KPIs).

3. Green Incentive Systems: Offer recognition or non-monetary incentives for departments and employees implementing successful eco-initiatives, reinforcing intrinsic motivation for sustainability (Bindeebea et al., 2025).
4. Internal Green Procurement Policies: Mandate environmentally sustainable purchasing processes across all public institutions, supported by GHRM-based awareness and compliance training.

Such interventions redefine HRM not as an administrative function but as a transformative policy tool—one that constructs a workforce ethically aligned with the broader sustainability mission of government. When combined with responsible innovation, GHRM strengthens the moral legitimacy of public administration, enhances employee engagement, and supports long-term cultural change (Lawter & Garnjost, 2025).

Embedding Innovation Ethics in Multi-Level Governance

The evidence also highlights the need for multi-level policy coherence—bridging local, national, and global innovation frameworks. Responsible Innovation (RI) and GHRM cannot operate effectively in isolation; they require vertical alignment between institutional levels and horizontal coordination across sectors.

At the local level, regional governments such as Gorontalo Province can establish Eco-Governance Units tasked with integrating RIP–GHRM principles into day-to-day operations, linking administrative innovation with environmental management. These units could serve as “living laboratories” for adaptive policy experimentation, echoing the *responsible experimentation* ethos emphasized by (Biegelbauer et al., 2025).

At the national level, ministries should formalize cross-sector collaborations that tie innovation policy to green employment strategies—ensuring that state-led development initiatives also advance sustainability competencies within the civil service. Institutional partnerships between the Ministry of Environment, the National Civil Service Agency, and local governments could enable standardized sustainability metrics in HR systems (Brás & Robaina, 2024; Tessema, 2025).

At the international level, alignment with SDG frameworks and Paris Agreement commitments requires that public institutions measure not only carbon outcomes but also ethical and behavioral dimensions of innovation. Integrating RIP–GHRM metrics into national sustainability reporting would position Indonesia as a regional leader in the governance of ethical innovation (Olukorede, 2025; World Economic Forum, 2025).

Such multi-layered governance integration transforms Responsible Innovation from a conceptual model into a *policy architecture* anchoring sustainability in everyday institutional routines, leadership development, and stakeholder accountability systems.

Reframing Civil Service Reform through Responsible Innovation

The study’s findings underscore a broader transformation in public-sector philosophy: from bureaucratic efficiency toward ethical adaptability. In practical terms, embedding responsible innovation within HRM systems reframes civil service reform as a human-centered, reflective process. Rather than focusing solely on procedural compliance, reform efforts should cultivate reflective competence—the ability of public officials to evaluate the ethical, social, and ecological implications of their decisions.

This reorientation supports the transition from *command-and-control administration* to *responsive, learning-based governance*. When linked to the AMO framework, GHRM can act as a developmental scaffold—enhancing officials’ environmental capabilities (ability), nurturing moral and ecological motivation (motivation), and expanding

participatory spaces for policy co-creation (opportunity) (Bos-Nehles et al., 2023; Ma & Wang, 2024).

From a cultural standpoint, this transformation aligns with Indonesia's collectivist values and public service ethos, allowing the moral tenets of Responsible Innovation to resonate with local traditions of *gotong royong* (mutual cooperation) and stewardship of communal resources. As such, Responsible Innovation and GHRM do not disrupt local norms; they revitalize them within a sustainability paradigm, bridging global ethics with indigenous governance wisdom.

Strategic Roadmap for Policymakers

Drawing from these findings, a roadmap for embedding responsible innovation and GHRM in public administration is proposed:

1. Policy Design – Integrate RIP principles into national civil service law, sustainability strategies, and innovation policy frameworks.
2. Institutional Capacity – Develop cross-ministerial training programs in environmental ethics and anticipatory governance.
3. Coordination Mechanisms – Establish inter-agency councils linking innovation, HRM, and environmental portfolios for policy coherence.
4. Evaluation and Metrics – Use composite sustainability indicators that combine environmental, social, and ethical dimensions (Hair et al., 2021).
5. Knowledge Networks – Build collaborative learning platforms connecting academia, civil society, and government (Biegelbauer et al., 2025).

These steps collectively enable governments to transition from *policy compliance* to *policy reflexivity*, ensuring that innovation serves public value while advancing ecological and social resilience.

In essence, Responsible Innovation and Green HRM represent a new paradigm of green statecraft—a governance model where ethical foresight, human capability, and environmental stewardship converge to realize the vision of *Innovation and Green Development*: advancing sustainable transformation through the moral evolution of public institutions..

CONCLUSION

This study provides empirical and theoretical evidence that Responsible Innovation Practices (RIP) significantly enhance Organizational Sustainability (OS), both directly and indirectly, through the mediating mechanism of Green Human Resource Management (GHRM). Using quantitative analysis via PLS-SEM on survey data from 300 public officials in Gorontalo Province, Indonesia, the results demonstrate that when innovation is governed by ethical and participatory principles—anticipation, inclusion, reflexivity, and responsiveness—it leads to measurable sustainability outcomes.

Specifically, the path $RIP \rightarrow GHRM$ ($\beta = 0.516$) indicates that responsible innovation directly shapes green HR strategies, while $GHRM \rightarrow OS$ ($\beta = 0.252$) and $RIP \rightarrow OS$ ($\beta = 0.286$) confirm that these practices translate into organizational sustainability. The indirect effect ($\beta = 0.130$) validates partial mediation, confirming GHRM as a strategic bridge linking ethical innovation with sustainable governance. The model's explanatory power ($R^2_{GHRM} = 0.267$; $R^2_{OS} = 0.220$) and predictive accuracy (positive Q^2 , PLSpredict) underscore its robustness and policy relevance.

These findings affirm that the integration of ethical innovation and human-centered HRM practices is essential for advancing sustainable governance in the public sector, aligning institutional behavior with Indonesia's broader *Green Transformation Roadmap 2045* and the Sustainable Development Goals (SDGs).

From a theoretical standpoint, this study advances the literature in three key ways. First, it extends Responsible Innovation Theory (RIT) beyond corporate and technological domains (Lubberink et al., 2017; Stilgoe et al., 2013) into public governance. By integrating RIT with GHRM, the research conceptualizes how moral foresight becomes embedded in administrative systems through human capital mechanisms.

Second, by aligning RIT with the Ability–Motivation–Opportunity (AMO) framework (Bos-Nehles et al., 2024), the study bridges ethical philosophy with behavioral theory. It explains how ethical innovation translates into performance through enhanced employee ability (skills), motivation (incentives), and opportunity (participation)—turning moral intent into measurable outcomes.

Third, by connecting these frameworks with Stakeholder Theory (Valentinov, 2023) and the Natural Resource-Based View (NRBV) (Li et al., 2024; Zihan et al., 2024), this research provides a multi-level explanation of sustainable capability formation. It positions ecological responsibility and stakeholder engagement as strategic resources that reinforce organizational legitimacy and long-term resilience. Collectively, this synthesis contributes a holistic theoretical model explaining how ethics, human capability, and ecological stewardship converge to drive sustainability transitions in public institutions.

Practically, the study offers clear implications for policymakers and administrators. It demonstrates that embedding responsible innovation into HR systems enhances both ethical accountability and environmental performance. GHRM emerges as a critical policy lever—transforming values into institutional behavior through recruitment, training, evaluation, and incentive mechanisms (Ahmad et al., 2025; Chowdhury et al., 2025). For Indonesia’s public sector, these findings suggest actionable priorities:

1. Institutionalize Responsible Innovation within civil service frameworks and environmental policies.
2. Integrate sustainability literacy into public-sector leadership programs.
3. Align HRM systems with ethical and ecological performance indicators.
4. Foster stakeholder collaboration for participatory policy design (Braun & Starkbaum, 2023).
5. Build adaptive feedback mechanisms to ensure continuous learning (Ehlers et al., 2025).

By implementing these measures, public institutions can transition from bureaucratic efficiency toward reflexive governance—a model where learning, adaptability, and responsibility define sustainable performance.

Beyond technical innovation, this study emphasizes the moral dimension of sustainability. Responsible Innovation reframes governance as a process of ethical reflection and societal stewardship (Long & Blok, 2023). Within Indonesia’s cultural context, embedding RIP into GHRM harmonizes global ethics with local values of *gotong royong* (mutual cooperation) and *amanah* (trust-based accountability). This cultural integration strengthens legitimacy and fosters civic participation in sustainability transitions.

Ultimately, the findings reaffirm that the path toward sustainable governance lies not only in new technologies or regulations but in ethical transformation—cultivating institutions capable of questioning, learning, and evolving. Responsible Innovation and GHRM together create the foundation for an adaptive, transparent, and future-oriented civil service.

The present study provides a strong conceptual and empirical foundation for understanding the proposed model, while also suggesting promising avenues for further inquiry. Future research may adopt longitudinal or mixed-method designs to capture dynamic learning effects and contextual evolution over time.

Expanding the scope through comparative analyses across different regions and policy domains—such as energy transition, urban resilience, and digital governance—could enhance the model’s external validity and applicability. Additionally, the integration of qualitative approaches and AI-assisted analytical tools may yield deeper insights into how responsible innovation values are embedded within varying administrative and cultural settings. Collectively, these efforts would strengthen theoretical understanding and contribute to the advancement of sustainable and ethical governance practices.

In conclusion, Responsible Innovation Practices (RIP) and Green Human Resource Management (GHRM) are not separate management trends but complementary forces shaping the moral and ecological foundations of governance. By translating ethical innovation into human systems, public organizations can transform sustainability from a rhetorical ideal into a daily institutional reality.

This study contributes to the central vision of *Innovation and Green Development*: that the future of sustainability will not be built solely through scientific progress, but through the moral evolution of our institutions, our leadership, and our collective responsibility toward the planet.

Data Availability Statement

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

Due to institutional confidentiality agreements and ethical considerations related to public-sector participants, raw data cannot be made openly accessible. However, anonymized or aggregated datasets (e.g., PLS-SEM outputs) can be shared for academic and non-commercial research purposes upon request.

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DECLARATION OF CONFLICTING INTERESTS

The authors declare no competing financial or personal interests that could have influenced the conduct, analysis, or interpretation of this research. All stages of the study were conducted independently and without external funding or institutional bias.

Use of Generative AI: The authors used *ChatGPT (version September 2025)* for linguistic clarity and grammatical refinement. The content, data interpretation, and all conclusions were entirely developed, reviewed, and verified by the authors, who retain full responsibility for the integrity and accuracy of the published manuscript.

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