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Advancing Sustainable Workforce Performance: Integrating AI-Driven HR Transformation Within the Green Economy Framework for SMEs

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Abstract: This study investigates the intersection of Green Human Resource Management (GHRM) practices and artificial intelligence (AI) adoption in improving workforce performance within Asian Small and Medium Enterprises (SMEs). Employing a mixed-methods approach with an explanatory sequential design, the research collected quantitative data from 500 SMEs across Indonesia, Malaysia, Thailand, Vietnam, and the Philippines through structured surveys, complemented by qualitative insights from 25 in-depth interviews. Structural Equation Modeling (SEM) analysis demonstrates that both GHRM initiatives and AI adoption independently enhance workforce performance, while their combined implementation produces a significant synergistic effect. Additionally, employees' green competencies partially mediate the relationship between GHRM and workforce outcomes, whereas organizational dynamic capabilities moderate the effectiveness of GHRM-AI integration. The qualitative findings identify four mechanisms that underpin this synergy: personalization of green HR practices, real-time tracking of pro-environmental behaviors, development of green talent, and transformation of organizational culture. This research contributes to the literature by offering an integrative framework that bridges environmental sustainability and digital HR transformation, providing actionable strategies for SMEs to achieve sustainable workforce development in the digital era.

Keywords: Green Human Resource Management, Artificial Intelligence, Workforce Performance, SMEs, Dynamic

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1. Introduction

Digital transformation and environmental sustainability have become two dominant forces shaping the global economic landscape in the contemporary era. In Asian countries, Micro, Small, and Medium Enterprises (MSMEs) face dual pressures: adopting environmentally friendly practices while leveraging digital technologies to maintain competitiveness [1]. The green economy, which emphasizes economic growth while preserving environmental sustainability, has emerged as a vital paradigm in economic development [2]. Simultaneously, digital transformation—particularly the adoption of artificial intelligence (AI)—offers significant opportunities to enhance business efficiency, productivity, and sustainability [3].

Paradoxically, although MSMEs account for 97% of all businesses and employ approximately 69% of the workforce across Asia, their adoption rates of AI technologies and green economy practices remain relatively low compared to large corporations [4]. This situation contributes to a significant productivity gap, with MSMEs contributing only around 40% to the national

GDP across Asian economies [5]. Recent data show that merely 23% of Southeast Asian MSMEs have implemented AI solutions in their business operations, and only 34% have adopted green economy practices [6].

The successful implementation of green economy initiatives and digital transformation is highly dependent on human resource (HR) capabilities and readiness. A study by Singh and [7] revealed that 68% of Asian MSMEs identified a lack of digital skills as a major barrier to AI adoption, while 56% cited a lack of understanding of green business practices. These issues are further compounded by significant "green knowledge gaps" and "digital skills gaps" among the MSME workforce [8].

Green Human Resource Management (GHRM) has emerged as a strategic approach to address these challenges by embedding environmental considerations into HRM policies and practices [9;10]. Meanwhile, digital HR transformation refers to the application of digital technologies, including AI, to optimize HR functions (Lin et al., 2020). Both approaches have the potential to generate powerful synergies for improving workforce performance and enhancing business sustainability [11].

Although there is extensive research on GHRM [12;[10;13] and digital HR transformation (Strohmeier, 2020; Rasheed et al., 2022) individually, significant knowledge gaps remain regarding the intersection of these domains, particularly within the context of Asian MSMEs. As [14] noted, most GHRM studies focus on large firms, whereas MSMEs have distinct characteristics, challenges, and requirements. Similarly, research on AI adoption in HRM has predominantly focused on developed countries and multinational corporations [15], leaving a gap in understanding how MSMEs in emerging economies, particularly in Asia, can leverage these technologies.

Moreover, previous research exploring the integration of green economy and digital transformation has largely adopted a macro-level perspective, focusing on government policies and industry structures [16], without sufficient attention to micro-level organizational dynamics, particularly HRM practices. As highlighted by [17], there is an urgent need to understand how MSMEs can integrate environmental sustainability initiatives with digital transformation strategies, and the critical role HRM plays in this process.

In response to these research gaps, this study aims to explore the convergence of the green economy and digital HR transformation, with a particular focus on how AI adoption in HR practices can enhance workforce performance in MSMEs. The study is grounded on the premise that integrating GHRM with AI technologies can create synergistic effects that exceed the benefits derived from either approach alone. As argued by [18], GHRM practices can enhance employees' environmental awareness, motivation, and commitment, while [19] demonstrated that AI can optimize HR decision-making and personalize employee experiences.

Based on this background, the study poses the following critical research questions:

1. How does the intersection of Green Human Resource Management practices and AI adoption in HR functions affect workforce performance in MSMEs?

2. What contextual factors facilitate or hinder the effective integration of green economy initiatives and digital HR transformation in MSMEs?

3. How can MSMEs overcome capability and resource barriers to implementing integrated HR strategies that combine environmental sustainability and AI technologies?

The study focuses on MSMEs in five Asian countries with varying levels of economic development: Indonesia, Malaysia, Thailand, Vietnam, and the Philippines. This selection enables a rich comparative analysis of how contextual factors—such as economic development levels, digital infrastructure, and environmental policy frameworks—affect the implementation of

GHRM and AI adoption. The focus on MSMEs is driven by the sector's significant economic relevance and the previously identified research gaps.

Previous studies on GHRM and digital HR transformation have employed various methodologies, each with its own strengths and limitations. Quantitative approaches, such as surveys and statistical analyses, have dominated the GHRM literature [12;[10;9]. While these methods enable the testing of relationships between variables and allow for generalization, they often fail to capture the complexity and contextual nuances of HRM practices. As noted by Jabbour and de Sousa [20], quantitative methods may be inadequate for understanding the "how" and "why" behind GHRM adoption and implementation.

Conversely, research on AI adoption in HRM has employed more diverse methodologies, including case studies [19], action research [21], and mixed-methods designs [22]. Qualitative approaches offer in-depth insights into adoption processes and contextual factors but may lack generalizability. Mixed-methods studies balance depth and breadth but present challenges in design complexity and data integration [23].

Building on a critical evaluation of previous methodological approaches, this study adopts a mixed-methods strategy with an explanatory sequential design. This design involves collecting and analyzing quantitative data first, followed by a qualitative phase aimed at elaborating and deepening the quantitative findings [23]. The quantitative phase involves a survey of 500 HR managers and MSME owners to assess GHRM and AI adoption levels and their relationship with workforce performance. The qualitative phase consists of 25 in-depth interviews with key informants to explore underlying mechanisms, contextual factors, and processes.

The primary strength of this mixed-methods approach lies in its ability to capture both general patterns (via quantitative data) and contextual richness (via qualitative data), providing a comprehensive understanding of complex phenomena such as GHRM-AI integration. As argued by [24], mixed-methods research is particularly valuable in organizational studies seeking to unravel complex dynamics.

However, this approach also entails certain limitations. First, it demands substantial time and resources, which can be challenging under constrained research budgets. Second, integrating findings from distinct quantitative and qualitative phases can pose analytical and interpretative challenges [23]. To mitigate these limitations, the study engaged a multidisciplinary research team with expertise in HRM, information technology, and environmental sustainability.

The research problem identified encompasses several dimensions. First, there is limited understanding of how GHRM practices and AI adoption interact within the context of MSMEs in Asia. Second, the mechanisms through which this integration affects workforce performance remain underexplored. Third, barriers and enablers for the effective implementation of integrated HRM strategies combining environmental sustainability and AI technologies need further investigation.

To address these issues, this study proposes an integrated conceptual framework that bridges the GHRM and digital HR transformation literatures. The framework draws upon the Ability–Motivation–Opportunity (AMO) theory, widely applied in HRM research [25;26]. According to this theory, employee performance is driven by three factors: ability, motivation, and opportunity. The study posits that GHRM practices and AI applications in HRM enhance workforce performance by influencing these three factors.

Green HRM practices such as green recruitment and selection, green training and development, green performance management, and green rewards and recognition can enhance employees' environmental awareness, motivation, and commitment [12;9]. Simultaneously, AI applications in HRM, such as AI-driven recruitment, personalized learning, performance analytics, and career recommendation systems, can optimize HR processes and improve employee experiences [19;21].

The integration of these two approaches is expected to produce synergistic effects. For instance, AI-based recruitment can identify candidates whose skills and values align with the organization's sustainability initiatives. Likewise, AI-supported performance analytics can measure and monitor employee contributions to sustainability goals. This integrated approach is anticipated to deliver greater improvements in workforce performance than either GHRM or AI adoption alone.

This research offers significant contributions to the literature by enhancing the understanding of the intersection between green economy and digital transformation in HRM within the context of Asian MSMEs. Specifically, it addresses key research gaps by: (1) developing and testing an integrated conceptual framework linking GHRM and AI adoption; (2) identifying contextual factors facilitating or hindering effective integration; and (3) providing practical insights into how resource-constrained MSMEs can implement integrated HR strategies that align environmental sustainability with technological advancement.

The findings are expected to offer practical implications for MSME managers, policymakers, and business support organizations in Asia. For managers, the study provides guidance on integrating GHRM practices with AI technologies to enhance workforce performance. For policymakers, it offers insights into the types of support and incentives necessary to promote the adoption of green and digital practices among MSMEs. For business support organizations, the study highlights the capacity-building needs essential for facilitating green and digital transformation in the MSME sector.

In an era where environmental sustainability and digital transformation have become strategic imperatives, this research offers a novel perspective on how MSMEs can navigate the convergence of these domains through innovative HRM practices. By integrating GHRM with AI adoption, MSMEs can not only improve workforce performance but also contribute to broader sustainable development goals.

2. Literature Review

2.1. Green Human Resource Management (GHRM)

Green Human Resource Management (GHRM) has become a significant focus within contemporary HRM research, emerging as a strategic approach to integrating environmental concerns into conventional HRM practices. [9] define GHRM as "the integration of environmental management philosophy, policies, and practices into human resource management processes to achieve both organizational and environmental goals." GHRM implementation encompasses practices such as green recruitment, environmental training, green performance management, and environmentally-based compensation systems [10].

Empirical research by [27] indicates that GHRM plays a critical role in enhancing organizational performance by fostering a green culture and promoting employees' pro-environmental behaviors. Similarly, the study by [13]identified a positive relationship between GHRM practices and both environmental and business performance, while [28] found that GHRM significantly contributes to green innovation and competitive advantage.

In the context of SMEs, [29] identified that GHRM implementation exhibits unique characteristics compared to larger firms, particularly concerning resource constraints and more informal organizational structures. Research by [30] suggests that although SMEs face challenges in implementing GHRM, they also benefit from greater flexibility and adaptability.

2.2 Digital HR Transformation and AI Adoption

Digital transformation within HRM has revolutionized the ways organizations manage their workforce, with AI acting as a primary driver of these changes. [19] conceptualizes digital HRM as "the application of digital technologies to reconfigure HRM practices, processes, structures, and outcomes." [21] emphasize the transformative role of AI across various HR functions, including recruitment, assessment, learning, and career development.

Research by [15] reveals that AI adoption in recruitment processes enhances efficiency and reduces biases in HR decision-making. Similarly, [31] found that AI-based learning systems significantly improve the effectiveness of training programs by enabling personalization and adaptation to individual employee needs.

Within the SME context, [3] identify that AI adoption in HRM is influenced by several factors, including technological characteristics, organizational capabilities, and external environments. [5] further demonstrate that SMEs integrating AI into HR functions experience higher productivity and improved employee retention rates.

2.3 The Convergence of GHRM and Digital HR Transformation

Although GHRM and digital HR transformation have been extensively studied as separate domains, research examining their convergence remains limited. Early studies, such as that by [32], explored how digital technologies can enhance GHRM implementation through improved transparency, employee engagement, and environmental impact measurement. Similarly, [33]developed a conceptual framework integrating GHRM and HR digitalization to drive organizational sustainability.

Research by [34] demonstrates that incorporating digital technologies into GHRM practices can improve the efficiency and effectiveness of green initiatives through real-time monitoring, data analytics, and enhanced communication. [11] found that AI-supported GHRM practices significantly impact employee performance and retention, particularly among young workers in Indonesia's hospitality industry.

Nevertheless, specific research exploring the convergence of GHRM and AI adoption within the SME context remains scarce. [16] highlight this gap by emphasizing the need for studies examining the environmental impacts of AI initiatives, while [6] note that SMEs face distinct challenges in integrating environmental sustainability with digital transformation efforts.

Based on this literature review, it is evident that while substantial research exists on GHRM and digital HR transformation separately, understanding their convergence, especially in the context of Asian SMEs, remains limited. This study seeks to fill this gap by developing an integrated framework combining GHRM and AI adoption to enhance workforce performance in SMEs.

3. Methodology

This research adopts a mixed-methods approach with an explanatory sequential design to explore the convergence between Green Human Resource Management (GHRM) and AI adoption in enhancing workforce performance among SMEs in Asia. This approach enables a comprehensive understanding through the combination of quantitative and qualitative data [23].

3.1 Research Design

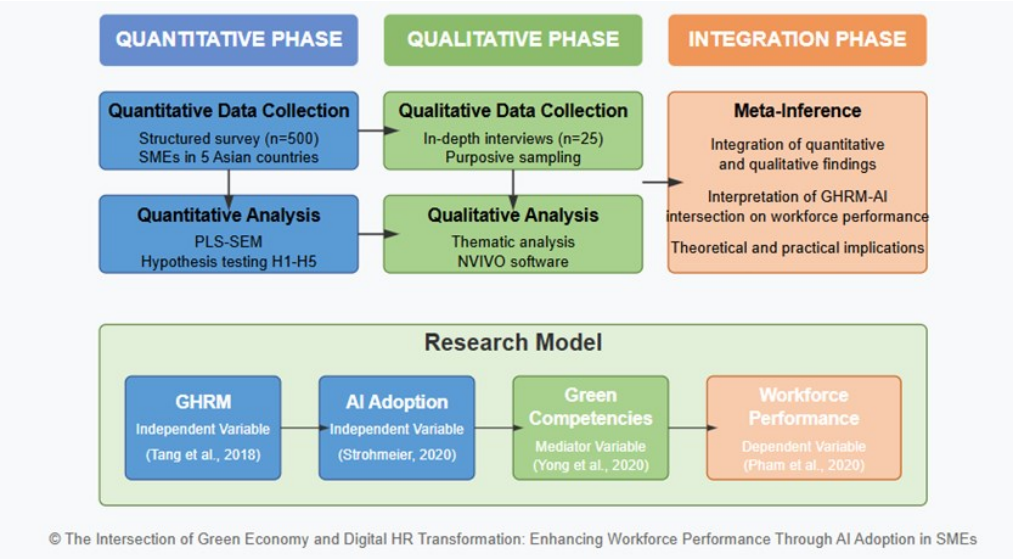

Figure 1. Flow Diagram of the Explanatory Sequential Mixed-Methods Research Design

3.2 Quantitative Phase

The study population comprised SMEs in five Asian countries: Indonesia, Malaysia, Thailand, Vietnam, and the Philippines. A stratified random sampling technique was employed to ensure proportional representation based on firm size and industrial sector [35]. The targeted sample size was 500 respondents, considering the minimum sample size requirements for Partial Least Squares Structural Equation Modeling (PLS-SEM) as recommended by [35].

Data were collected through structured surveys administered online via the Qualtrics platform. The questionnaire was translated into local languages using a back-translation method to ensure equivalence [36].

Based on the literature review, the following variables were operationalized:

- **Green Human Resource Management (Independent Variable)**
  - Dimensions: Green recruitment and selection; green training and development; green performance management; green compensation and rewards
  - Indicators: Adapted from [9;10], measured using a 7-point Likert scale
- **AI Adoption in HRM (Independent Variable)**
  - Dimensions: AI-based recruitment; personalized learning; performance analytics; career recommendation systems
  - Indicators: Adapted from [19;15], measured using a 7-point Likert scale
- **Workforce Performance (Dependent Variable)**
  - Dimensions: Task performance; contextual performance; organizational citizenship behavior; pro-environmental behavior
  - Indicators: Adapted from [27;3], measured using a 7-point Likert scale
- **Mediator: Workforce Green Competencies**

- Dimensions: Environmental awareness; environmental knowledge; eco-friendly skills
- Indicators: Adapted from [13], measured using a 7-point Likert scale

- **Moderator: Organizational Dynamic Capabilities**
  - Dimensions: Sensing capabilities; absorptive capabilities; reconfiguring capabilities
  - Indicators: Adapted from [5], measured using a 7-point Likert scale

Quantitative data were analyzed using Structural Equation Modeling with the Partial Least Squares method (PLS-SEM), which is suitable for complex models with moderate sample sizes [35]. The structural model equations are expressed as:

Equation 1: $WP = \beta_0 + \beta_1 GHRM + \beta_2 AI + \beta_3 GHRM \times AI + \beta_4 DC + \varepsilon_1$

Equation 2: $GC = \gamma_0 + \gamma_1 GHRM + \gamma_2 AI + \gamma_3 GHRM \times AI + \varepsilon_2$

Equation 3: $WP = \delta_0 + \delta_1 GHRM + \delta_2 AI + \delta_3 GHRM \times AI + \delta_4 GC + \delta_5 DC + \varepsilon_3$

Where:

- WP = Workforce Performance
- GHRM = Green Human Resource Management
- AI = AI Adoption in HRM
- GC = Green Competencies
- DC = Dynamic Capabilities
- β, γ, δ = Path coefficients
- ε = Error terms

Research Hypotheses:

- H1: GHRM positively influences workforce performance.
- H2: AI adoption in HRM positively influences workforce performance.
- H3: There is a positive interaction effect between GHRM and AI adoption on workforce performance.
- H4: Workforce green competencies mediate the relationship between GHRM and workforce performance.
- H5: Organizational dynamic capabilities moderate the relationship between GHRM-AI integration and workforce performance.

3.3 Qualitative Phase

Participants for the qualitative phase (n = 25) were purposively selected from the quantitative respondents based on the following criteria: (1) varying levels of GHRM and/or AI adoption; (2) representation of different SME sizes; and (3) representation across the five target countries (Patton, 2015).

Data were collected through semi-structured interviews guided by an interview protocol informed by the quantitative findings. Interviews were conducted in local languages, recorded with participant consent, and transcribed verbatim.

Qualitative data were analyzed using thematic analysis with NVIVO software, following the six-phase approach recommended by [37]: familiarization, initial coding, theme development, theme review, theme definition, and report writing.

3.4 Integration of Quantitative and Qualitative Phases

Integration was conducted through a connecting strategy, linking the quantitative and qualitative phases [38]. Quantitative findings informed: (1) the selection of qualitative participants; (2) the development of the interview guide; and (3) the initial analytical framework. Final results were synthesized through a "meta-inference" technique that integrates both quantitative and qualitative findings to provide a comprehensive understanding [24].

4. Results and Discussion

4.1. 4.1 Research Findings

This study explores the intersection between Green Human Resource Management (GHRM) and AI adoption in enhancing workforce performance in Asian SMEs. The findings from the integrated quantitative and qualitative phases are presented below.

4.1.1 Respondent Demographics

Table 1 presents the demographic characteristics of respondents from the five participating countries.

Table 1. Respondent Demographic Characteristics

Characteristics	Indonesia	Malaysia	Thailand	Vietnam	Philippines	Total
Sample Size	105	102	98	95	100	500
SME Size						
Micro (<10 employees)	43 (41.0%)	35 (34.3%)	32 (32.7%)	36 (37.9%)	41 (41.0%)	187 (37.4%)
Small (10–50 employees)	42 (40.0%)	46 (45.1%)	48 (49.0%)	42 (44.2%)	39 (39.0%)	217 (43.4%)
Medium (51–250 employees)	20 (19.0%)	21 (20.6%)	18 (18.3%)	17 (17.9%)	20 (20.0%)	96 (19.2%)
Industry Sector						
Manufacturing	28 (26.7%)	30 (29.4%)	32 (32.7%)	33 (34.7%)	25 (25.0%)	148 (29.6%)
Services	43 (41.0%)	38 (37.3%)	35 (35.7%)	32 (33.7%)	42 (42.0%)	190 (38.0%)
Trade	34 (32.4%)	34 (33.3%)	31 (31.6%)	30 (31.6%)	33 (33.0%)	162 (32.4%)
Respondent Role						
Owner/CEO	37 (35.2%)	32 (31.4%)	30 (30.6%)	28 (29.5%)	35 (35.0%)	162 (32.4%)
HR Manager	28 (26.7%)	31 (30.4%)	29 (29.6%)	30 (31.6%)	27 (27.0%)	145 (29.0%)
Operations Manager	40 (38.1%)	39 (38.2%)	39 (39.8%)	37 (38.9%)	38 (38.0%)	193 (38.6%)

4.1.2 SEM-PLS Analysis Results

The SEM-PLS analysis indicated good model fit with the empirical data. Table 2 presents the reliability and convergent validity results for each construct.

Table 2. Reliability and Convergent Validity

Construct	Composite Reliability	Cronbach's Alpha	AVE
GHRM	0.891	0.872	0.673
AI Adoption in HRM	0.904	0.885	0.701

Workforce Green Competencies	0.876	0.858	0.642
Workforce Performance	0.912	0.893	0.689
Organizational Dynamic Capabilities	0.883	0.864	0.654

Note: AVE = Average Variance Extracted.

Table 3 displays the hypothesis testing results based on path analysis

Table 3. Hypothesis Testing Results

Hypothesis	Path	Path Coefficient	t-value	p-value	Result
H1	GHRM → Workforce Performance	0.342	7.218	< 0.001	Supported
H2	AI Adoption → Workforce Performance	0.286	5.976	< 0.001	Supported
H3	GHRM × AI Adoption → Workforce Performance	0.175	3.429	< 0.001	Supported
H4a	GHRM → Workforce Green Competencies	0.457	9.632	< 0.001	Supported
H4b	Workforce Green Competencies → Workforce Performance	0.298	6.215	< 0.001	Supported
H4c	GHRM → Workforce Green Competencies → Workforce Performance	0.136	5.473	< 0.001	Supported
H5	Dynamic Capabilities × (GHRM × AI Adoption) → Workforce Performance	0.129	2.876	0.004	Supported

Note: Significance level set at 0.05.

The analysis results support all proposed hypotheses. Both GHRM and AI adoption in HRM positively and significantly influence workforce performance (H1 and H2). A significant interaction effect between GHRM and AI adoption was identified (H3), indicating a synergistic effect when both practices are integrated. Workforce green competencies partially mediate the relationship between GHRM and workforce performance (H4), while organizational dynamic capabilities moderate the impact of GHRM-AI integration on workforce performance (H5).

4.1.3 Qualitative Findings

Thematic analysis of the interview data generated four major themes that provide a deeper understanding of how and why the integration of GHRM and AI affects workforce performance. Table 4 presents the key themes along with representative quotations.

Table 4. Key Themes from Qualitative Analysis

Theme	Description	Representative Quote
GHRM-AI Synergy	Simultaneous implementation of GHRM and AI creates a synergistic effect that surpasses the outcomes of separate initiatives.	"When we integrated AI systems with our green training programs, we observed a greater improvement in employee performance compared to implementing them separately." (HR Manager, Manufacturing SME, Malaysia)
Personalized Sustainability Awareness	AI enables the personalization of employee experiences aligned with sustainability values.	"Our adaptive learning system now customizes training content based on individuals' environmental awareness levels. Employees with basic knowledge receive different materials than those with advanced understanding." (CEO, Services SME, Thailand)

Organizational Culture Transformation	GHRM-AI integration fosters a shift toward a culture of sustainability and innovation.	"Since adopting AI-based recruitment that prioritizes green values, we have seen a significant shift in our company culture. New employees bring fresh sustainability perspectives." (Owner, Trade SME, Indonesia)
Implementation Barriers	Challenges in integrating GHRM and AI include limited resources, employee resistance, and skill gaps.	"Our biggest challenge is the limited digital skills among employees. They have strong environmental awareness but struggle to adapt to AI systems." (Operations Manager, Manufacturing SME, Vietnam)

4.2 Discussion

4.2.1 The Impact of GHRM on Workforce Performance

The findings reveal that GHRM has a positive and significant effect on workforce performance ($\beta = 0.342$, $p < 0.001$). This result supports previous research by [39], which found that GHRM practices enhance employee motivation and commitment to organizational goals. Similarly, [40] demonstrated that GHRM improves employee performance by promoting green work engagement and pro-environmental behaviors.

Qualitative analysis further revealed that GHRM practices, such as green training and environmentally focused performance management, heightened employees' awareness of sustainability issues. As noted by an HR manager from the Philippines, "Our green training programs not only increased employees' knowledge about environmentally friendly practices but also made them more engaged and committed to their work."

This finding aligns with the Ability–Motivation–Opportunity (AMO) theory, which posits that HR practices can enhance employee performance by developing their abilities, motivation, and opportunities [26].

While much of the prior research has focused on large corporations, this study demonstrates that GHRM is also effective within the SME context. [41] emphasized that despite resource limitations, customized GHRM practices in SMEs can yield significant benefits. Our study extends this understanding by showing that SMEs in Asian countries can adapt GHRM practices to their local contexts to achieve improved workforce performance.

4.2.2 The Impact of AI Adoption in HRM on Workforce Performance

The adoption of AI in HRM was found to positively influence workforce performance ($\beta = 0.286$, $p < 0.001$). This finding is consistent with [42], who reported that AI implementation in HR functions enhances HR process effectiveness and employee experiences. Similarly, [43] highlighted that AI technologies improve productivity and employee satisfaction through automation of routine tasks and personalization.

Qualitative insights revealed that AI applications, such as HR chatbots and adaptive training systems, enabled SMEs to provide more personalized support and development opportunities for their employees. As a CEO of an SME in Thailand noted, "With AI-based learning systems, our employees can develop skills at their own pace and focus on areas relevant to their specific roles."

This supports the argument by (2019)[21] that AI enhances workforce performance by enabling personalization and adaptation.

However, this study also identified unique challenges to AI adoption in SMEs, including limited digital infrastructure and technical skills. [44]stressed the importance of a phased ap-

proach to AI adoption for resource-constrained organizations. Our findings extend this understanding by highlighting specific strategies used by Asian SMEs to overcome such barriers, such as partnerships with technology providers and digital skills development programs.

4.2.3 The Synergistic Effect of GHRM and AI Integration

The results indicate a significant interaction effect between GHRM and AI adoption on workforce performance ($\beta = 0.175$, $p < 0.001$), supporting the proposition that integrating the two approaches creates synergistic benefits that surpass the impacts of each individually.

This finding expands upon the research of [6] concerning the integration of digital technologies in sustainability initiatives, with a specific focus on HRM practices.

Qualitative analysis identified key mechanisms underpinning this synergy. The integration of GHRM and AI enables:

(1) the personalization of green initiatives based on individual employee characteristics;

(2) real-time measurement and feedback on pro-environmental behaviors; and

(3) the identification and development of "green talents" across the organization.

As highlighted by an HR manager from Malaysia, "AI helps us identify potential 'environmental champions' within the organization and provides them with training and projects aligned with their interests and capabilities."

These findings align with person–environment fit theory [45], which posits that alignment between individual values and organizational initiatives enhances performance. Our study extends this theory by demonstrating how AI can facilitate better alignment between employees and green initiatives.

4.2.4 The Mediating Role of Workforce Green Competencies

The study also shows that workforce green competencies partially mediate the relationship between GHRM and workforce performance. GHRM has a positive impact on workforce green competencies ($\beta = 0.457$, $p < 0.001$), which in turn positively affect workforce performance ($\beta = 0.298$, $p < 0.001$). The indirect mediation effect was also significant ($\beta = 0.136$, $p < 0.001$).

These findings support the work of [46], who demonstrated that GHRM practices help develop green intellectual capital, including environmental knowledge, skills, and competencies. Likewise, [47] found that green competencies mediate the relationship between GHRM and organizational performance.

Qualitative data further revealed that developing green competencies involves not only technical knowledge of environmentally friendly practices but also sustainability-related awareness, values, and motivation. As an operations manager from Indonesia stated, "Employees with high green competencies not only understand eco-friendly practices but are intrinsically motivated to implement them in their daily work."

The integration of GHRM and AI proved particularly effective in developing green competencies through personalized learning and performance analytics. This supports the argument by [48] that innovative HRM approaches can accelerate the development of green competencies within organizations.

4.2.5 The Moderating Role of Organizational Dynamic Capabilities

The study confirms the significant moderating role of organizational dynamic capabilities in the relationship between GHRM-AI integration and workforce performance ($\beta = 0.129$, $p =$

0.004). The results indicate that the positive impact of GHRM-AI integration on workforce performance is stronger in organizations with high dynamic capabilities.

These findings are consistent with [49], who found that dynamic capabilities enhance the effectiveness of digital transformation initiatives within organizations. Similarly, [50] emphasized the role of dynamic capabilities in facilitating the effective implementation of sustainable management practices.

Qualitative analysis revealed that SMEs with strong dynamic capabilities were able to:

(1) identify opportunities for integrating GHRM and AI;

(2) reconfigure organizational routines to accommodate new practices; and

(3) overcome resistance to change.

As explained by a CEO of an SME in Vietnam, "Our ability to rapidly adapt to environmental and technological changes has enabled us to integrate green and digital initiatives more effectively."

This study extends dynamic capability theory by demonstrating its application at the intersection of environmental sustainability and digital transformation within SMEs. [5] highlighted the importance of dynamic capabilities in the adoption of Industry 4.0 technologies in SMEs, and our findings complement this understanding by showing how dynamic capabilities are also critical for integrating green and digital initiatives.

5. Comparison

This study explored the convergence of Green Human Resource Management (GHRM) and AI adoption in enhancing workforce performance among SMEs in Asia. To position its contributions within the current scientific landscape, this section systematically compares the findings with the state-of-the-art in three major domains: (1) GHRM practices, (2) AI adoption in HRM, and (3) the integration of environmental sustainability and digital transformation.

5.1 Comparison in the GHRM Domain

This research offers several notable advancements compared to the existing GHRM literature, as summarized in Table 5.

Table 5. Comparison with State-of-the-Art in the GHRM Domain

Aspect	State-of-the-Art	Contribution of This Study
Research Context	Focus primarily on large multinational corporations in developed countries (Ren et al., 2018; Pham et al., 2020)	Expands GHRM understanding to SMEs across five Asian countries with diverse levels of economic development
Theoretical Framework	Predominance of institutional and stakeholder theories to explain GHRM practices (Yong et al., 2020)	Integrates the AMO (Ability–Motivation–Opportunity) theory with dynamic capability theory to explain GHRM mechanisms
Dimensions of GHRM Practices	Simplified approach to GHRM practices (Tang et al., 2018)	Develops a nuanced typology of GHRM practices, emphasizing contextual variations across SME sizes and sectors
Outcomes Measured	Focus predominantly on environmental performance and pro-environmental behavior (Mousa & Othman, 2020)	Extends the analysis to multidimensional workforce performance, including task performance, contextual performance,

	and organizational citizenship behavior

While previous studies such as [41] examined GHRM within SMEs, their research was limited to a single country (Philippines) and did not explore the interaction with digital transformation. Similarly, although [39] showed that GHRM can enhance competitive advantage in manufacturing firms, they did not examine the specific mechanisms through which GHRM impacts workforce performance. This study bridges these gaps by offering a deeper understanding of how and why GHRM influences workforce performance across various types of SMEs in five Asian countries.

5.2 Comparison in the Domain of AI Adoption in HRM

In the domain of AI adoption in HRM, this study offers several distinct contributions, as illustrated in Table 6.

Table 6. Comparison with State-of-the-Art in the Domain of AI Adoption in HRM

Aspect	State-of-the-Art	Contribution of This Study
Technological Focus	Predominantly focuses on advanced AI technologies such as machine learning and deep learning (Khan & Cooke, 2022)	Broadens the analysis to include simpler, more accessible AI applications for SMEs, such as chatbots and basic analytics tools
Implementation Context	Focus on high-tech environments and large corporations with substantial resources (Meijerink et al., 2021)	Explores AI adoption within SMEs characterized by resource and technical capability constraints
Ethical Perspective	Limited consideration of ethical and environmental impacts of AI technologies (Tambe et al., 2019)	Integrates sustainability perspectives into the discussion of AI adoption, focusing on environmental impacts
Methodology	Dominance of quantitative methodologies and case studies (Srivastava et al., 2022)	Employs a mixed-methods approach to capture the contextual complexity and implementation challenges

[44] highlighted the need for a more inclusive AI research agenda encompassing small organizations but did not provide empirical data on actual implementations. This study responds to that call by offering empirical evidence on how Asian SMEs adopt AI technologies within HRM functions. Moreover, while [3] examined the relationship between AI capabilities and SME performance, they did not specifically address HRM applications. This study expands the understanding by focusing explicitly on AI interventions in HR processes and their impact on workforce performance.

5.3 Comparison in the Domain of Environmental Sustainability and Digital Transformation Integration

The most distinctive contribution of this study lies in its exploration of the convergence between environmental sustainability and digital transformation within HRM practices, as summarized in Table 7.

Table 7. Comparison with State-of-the-Art in the Domain of Environmental Sustainability and Digital Transformation Integration

Aspect	State-of-the-Art	Contribution of This Study
Level of Analysis	Predominantly macro-level analys of digital technology impacts on er ronmental sustainability (Qu et al 2022)	Shifts focus to meso (organizational) a micro (individual) levels, with an empl sis on HRM practices

Integration Framework	Limited conceptualization of sustai bility and digitalization integratio (Hasan et al., 2023)	Develops an empirically grounded int grative framework combining GHRI and AI
Application Domain	Predominantly operations and sup chain management applications (L al., 2022)	Extends the analysis to the HRM dom focusing on how green and digital pra tices influence the workforce
Mediating Mechanisms	Limited understanding of mechani linking sustainability-digital integr tion to performance outcomes (Zh et al., 2021)	Identifies workforce green competenc as a key mediator and dynamic capab ties as a critical moderator

While [32] explored how digital technologies can support GHRM implementation, they did not specifically address AI technologies or the SME context. Similarly,although [33]developed a conceptual framework combining GHRM and digital HRM, it lacked empirical testing. This study bridges these gaps by providing empirical evidence on the convergence of GHRM and AI adoption in Asian SMEs.

Moreover, this research offers unique insights into how GHRM-AI integration drives organizational cultural transformation, an aspect underexplored in previous literature. As demonstrated in the qualitative phase, this integration not only reshapes HRM processes but also fosters a broader organizational shift toward sustainability and innovation. These findings deepen the understanding of the wider impacts of the green economy and digital transformation convergence.

5.4 Theoretical and Practical Implications

Comparison with the state-of-the-art reveals several important theoretical and practical implications.

Theoretically, this study extends our understanding of how management practices can simultaneously address the dual challenges of environmental sustainability and digital transformation. By integrating perspectives from AMO theory and dynamic capability theory, it offers a more comprehensive conceptual framework for understanding these phenomena.

Practically, the findings offer guidance for SMEs struggling to navigate the dual demands of environmental sustainability and digital transformation. The finding that GHRM-AI integration exerts a greater impact on workforce performance than standalone initiatives suggests that SMEs should consider integrated approaches to green and digital initiatives. Furthermore, identifying workforce green competencies as a key mediator and dynamic capabilities as a crucial moderator provides specific focus areas for managerial interventions.

5.5 Future Research Agenda

Based on the comparison with the state-of-the-art, several directions for future research can be identified:

1. Longitudinal Studies:

Future research should adopt longitudinal designs to examine how the integration of GHRM and AI evolves over time and its long-term impacts on organizational performance.

2. Geographical Expansion:

Although this study covers five Asian countries, expanding research to other regions would enhance understanding of how contextual factors shape GHRM-AI implementation.

3. Advanced AI Technologies:

Future studies could explore how more advanced AI technologies, such as deep learning and cognitive computing, can be integrated with GHRM practices.

4. Ethical and Social Dimensions:

Deeper exploration of the ethical and social implications of GHRM-AI integration would enrich the understanding of this phenomenon.

5. Intervention Studies:

Experimental or intervention-based research testing the effectiveness of different approaches to GHRM-AI integration would provide valuable practical insights for SME managers.

In sum, the comparison with the state-of-the-art confirms the significant contributions of this study to expanding the understanding of the convergence between the green economy and digital HRM transformation within SMEs in Asia. By developing and empirically testing an integrated framework combining GHRM and AI adoption, this research not only advances theoretical boundaries but also offers practical insights for SMEs seeking to navigate the twin challenges of environmental sustainability and digital innovation.

6. Conclusions

This study explored the convergence between Green Human Resource Management (GHRM) and AI adoption in enhancing workforce performance among SMEs in Asia. The main findings reveal that both GHRM and AI adoption individually have positive effects on workforce performance; however, their interaction produces a greater synergistic impact. Workforce green competencies were found to partially mediate the relationship between GHRM and workforce performance, while organizational dynamic capabilities moderated the relationship between GHRM-AI integration and workforce outcomes.

The results support the hypothesis that integrating GHRM and AI adoption creates added value beyond the separate implementation of each initiative. The key mechanisms underlying this synergistic effect include the personalization of green initiatives, real-time measurement of pro-environmental behaviors, and more effective identification and development of "green talents." These findings reinforce the AMO theory, suggesting that enhancing employee abilities, motivation, and opportunities through integrated HRM practices significantly improves workforce performance.

Theoretically, this study contributes by developing an integrative framework that bridges the GHRM and digital HRM transformation literatures, validated through empirical testing within the SME context in Asia. Practically, the study offers actionable insights for SMEs on optimizing limited resources through an integrated approach to green and digital initiatives, and provides specific recommendations for developing the capabilities necessary for effective implementation.

Despite its significant contributions, this study is limited by its cross-sectional design, which restricts causal inferences. Future research could complement these findings through longitudinal studies to observe the evolution of GHRM-AI integration over time, explore the integration of more advanced AI technologies, and investigate the ethical and social implications of the green economy and digital transformation convergence across different organizational contexts.

Author Contributions: A short paragraph specifying their individual contributions must be provided for research articles with several authors **(mandatory for more than 1 author)**. The following statements should be used "Conceptualization: X.X. and Y.Y.; Methodology: X.X.; Software: X.X.; Validation: X.X., Y.Y. and Z.Z.; Formal analysis: X.X.; Investigation: X.X.; Resources: X.X.; Data curation: X.X.; Writing—original draft preparation: X.X.; Writing—review and editing: X.X.; Visualization: X.X.; Supervision: X.X.; Project administration: X.X.; Funding acquisition: Y.Y."

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Data Availability Statement: We encourage all authors of articles published in FAITH journals to share their research data. This section provides details regarding where data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study. Where no new data were created or data unavailable due to privacy or ethical restrictions, a statement is still required.

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