Developing a Digital Green HRM Framework Leveraging Intelligent Computer Systems: A Change Management Approach to Optimize Human Resource Performance

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Abstract: This study presents an innovative Digital Green Human Resource Management (GHRM) framework, anchored in intelligent computer systems and integrated with a dynamic change management model to drive human resource performance optimization. Through a Systematic Literature Review (SLR) of 78 scholarly articles (2015–2025), five critical Digital GHRM dimensions emerge: digital green recruitment and selection, digital green training and development, digital green performance management, digital green compensation and rewards, and AI-augmented GHRM analytics. The framework further advances a four-pillar change management model encompassing green transformational leadership, digital-green competencies, sustainable organizational culture, and integrated measurement systems. Delphi-based validation highlights a phased integration strategy as pivotal for successful implementation. Compared to prevailing frameworks, this model demonstrates significant novelty by systematically embedding digitalization within GHRM processes while aligning with organizational sustainability objectives. Although empirical deployment is yet forthcoming, the framework offers robust, actionable insights and a scalable design, equipping organizations to navigate the complex intersection of digital transformation, green management, and human resource excellence.

Keywords: Green HRM; intelligent computer systems; change management; sustainability; digital transformation

1. Introduction

Today, organizations face a dual challenge in managing human resources: optimizing employee performance while simultaneously meeting growing environmental sustainability demands. The phenomena of global climate change and heightened environmental awareness have compelled organizations to integrate environmentally friendly practices into their operations, including in human resource management [1]. Green Human Resource Management (GHRM) has emerged as a strategic approach that aligns HR practices with organizational sustainability goals [2;3]. However, the implementation of GHRM across many organizations remains fragmented and is often not supported by the comprehensive use of digital technologies and intelligent systems.

Over the past decade, significant transformations have reshaped the global business landscape, driven by digitalization, climate change, and the COVID-19 pandemic. These devel-

opments have accelerated the adoption of digital technologies in HR practices, including virtual recruitment, online training, and cloud-based performance management systems [4]. Nevertheless, the integration of HR digitalization with GHRM practices remains suboptimal, particularly regarding the deployment of intelligent technologies such as artificial intelligence (AI), machine learning, and data analytics to support environmental sustainability [5] In Indonesia, [6] reported that although GHRM practices significantly contributed to employee performance and retention in the hospitality sector, the utilization of digital technologies within GHRM remains limited.

The urgency of this research is further underscored by global trends toward a green economy and regulatory pressures promoting environmental sustainability. International organizations such as the United Nations, through the Sustainable Development Goals (SDGs) and the Paris Agreement, advocate for carbon footprint reduction and the promotion of sustainable business practices [7]. Increasing demands from consumers, investors, and other stakeholders require organizations to demonstrate genuine environmental commitments. In this context, GHRM serves as a crucial instrument for embedding sustainability values and practices into organizational culture [8].

Despite the growing body of literature on GHRM, several research gaps persist. First, most studies focus on the impact of GHRM on organizational performance or employees' pro-environmental behaviors [5;9], with limited exploration of how digital systems and intelligent technologies can optimize GHRM implementation. Second, research on change management models for implementing Digital GHRM remains scarce, despite change resistance being a major barrier to organizational transformation [10;11]. Third, much of the existing research is concentrated in developed countries, while developing economies like Indonesia possess unique contextual dynamics that warrant closer examination [12;6].

Recent studies by [13;14] indicate that integrating GHRM with digital technologies can create synergies that enhance the effectiveness of sustainable practices and organizational performance. However, these studies do not offer comprehensive frameworks detailing how intelligent computer systems can optimize the entire GHRM cycle. Furthermore, the crucial aspect of change management in implementing new systems has received insufficient attention. Although [15] underscore the importance of a strategic approach to GHRM implementation, they fall short of providing a model that integrates digital technologies with change management strategies.

In response to these research gaps, this study formulates the following research questions:

1.How can a Digital GHRM framework based on intelligent computer systems be designed to optimize HR performance?

2.What are the key components of an effective change management model for implementing Digital GHRM?

3.How can the integration of digital technologies, GHRM practices, and change management strategies enhance HR performance and organizational sustainability?

The object of this study is the body of HRM practices and digital technology applications in HR management, as published in reputable international journals between 2015 and 2025. A Systematic Literature Review (SLR) approach is employed to comprehensively analyze the evolution and trends of research related to Digital GHRM and the use of intelligent computer systems in sustainable HRM practices. SLR is a research method that systematically and explicitly identifies, evaluates, and synthesizes research evidence relevant to specific research questions [16].

The SLR method has been applied in prior research on GHRM, such as [1], who conducted a systematic literature review of GHRM studies from 2007 to 2019, successfully identifying research trends and gaps. Similarly, [9] utilized meta-analytical techniques to explore the rela-

tionships between GHRM practices, green intellectual capital, and environmental performance in Malaysian hotels. These studies demonstrate the strength of the SLR approach in synthesizing research evidence and identifying patterns and gaps in the literature.

Nevertheless, the SLR method is not without limitations. First, the quality of an SLR heavily depends on the quality of the primary studies synthesized. Second, SLRs are susceptible to publication bias, wherein studies reporting positive findings are more likely to be published than those reporting null or negative results. Third, traditional SLR approaches may struggle to effectively integrate both qualitative and quantitative evidence. To mitigate these limitations, this study adopts a modified SLR approach that integrates bibliometric analysis, thematic analysis, and narrative synthesis to deliver a more comprehensive understanding of the Digital GHRM research landscape.

One of the core challenges in implementing GHRM is the gap between conceptualization and practical execution. Although many organizations recognize the strategic value of GHRM, implementation often falters due to a lack of clear operational frameworks, resistance to change, and difficulties in impact measurement [17]. Furthermore, although HR digitalization and GHRM have individually evolved, their integration has yet to be fully explored and leveraged [18]. This gap becomes even more pronounced in the context of deploying intelligent technologies such as AI and big data analytics within GHRM practices.

To address these challenges, this research proposes the development of a Digital GHRM framework based on intelligent computer systems, integrated with a strategic change management model. The framework aims to integrate traditional GHRM practices with digital technologies and intelligent systems, optimizing the full HRM cycle, from green recruitment and training to performance management and compensation. This approach will leverage AI, data analytics, and the Internet of Things (IoT) to automate processes, enhance data-driven decision-making, and facilitate the implementation of environmentally sustainable practices.

The proposed change management model will focus on four key dimensions: transformational leadership, digital-green competency development, the cultivation of a sustainability-oriented organizational culture, and integrated performance measurement systems. This model will offer strategic guidance for organizations to overcome resistance and ensure a smooth transition toward the adoption of Digital GHRM.

This study is expected to contribute significantly to both theoretical and practical domains. Theoretically, it seeks to expand the GHRM literature by integrating insights from human resource management, information technology, environmental sustainability, and change management. Practically, the developed framework offers guidance for HR practitioners and executives to effectively implement Digital GHRM initiatives, thereby enhancing HR performance while simultaneously advancing organizational sustainability objectives.

GHRM literature has significantly evolved in recent years, focusing on various dimensions such as green recruitment, sustainable training and development, environmental performance management, and sustainability-based compensation and rewards [11;10]. For instance, [19] investigated the impact of GHRM practices on employees' eco-friendly behaviors in hotels in Korea and the United States, finding that sustainability training and incentives could significantly enhance pro-environmental behaviors. Similarly, [5] explored how GHRM practices foster organizational citizenship behaviors for the environment (OCBE) in Vietnamese hotels, revealing the crucial role of GHRM in cultivating sustainability-supportive organizational cultures.

Parallel to GHRM research, HR digitalization studies have grown rapidly, examining how digital technologies enhance the efficiency and effectiveness of HR functions [4]. For example, [20] explored the transformative impact of AI and intelligent technologies on HR practices, including algorithm-based recruitment, virtual reality training, and predictive HR analytics. [21] similarly analyzed the implications of digital technologies for HR practices, highlighting both opportunities and challenges.

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Although these two research streams have advanced in parallel, their integration remains underexplored. Recent efforts have begun to address this intersection. For instance, [4] examined the role of HR analytics in promoting sustainable development through GHRM, suggesting that analytics could help organizations target sustainability interventions more effectively. However, a comprehensive practical framework for implementation remains absent.

Methodologically, GHRM research has employed various approaches, including quantitative surveys [19;5], qualitative case studies [13], and literature reviews [11;1]. Systematic literature reviews have proven especially valuable in identifying trends and gaps. [1], for example, identified five major research clusters in GHRM: its conceptualization and scope, its relationship with environmental performance, influencing factors, outcomes, and its linkage with green supply chain management.

Building on this body of literature, the present study aims to integrate and extend both GHRM and HR digitalization streams by developing a comprehensive Digital GHRM framework based on intelligent computer systems. This framework will address existing gaps by providing a conceptual model that integrates GHRM practices, digital technologies, intelligent systems, and change management strategies, offering a roadmap for organizations aiming to enhance HR performance and sustainability outcomes.

This research employs a modified SLR approach, integrating bibliometric analysis, thematic analysis, and narrative synthesis. This method enables the identification of research trends, emerging themes, and patterns in the current literature while offering a deeper exploration of critical issues. Findings from the SLR will inform the development of the comprehensive Digital GHRM framework and the accompanying change management model to facilitate effective implementation.

Thus, this study aspires to make substantial contributions to the advancement of both theoretical knowledge and practical applications in the fields of GHRM and HR digitalization. The resulting framework will assist organizations in harnessing digital technologies and intelligent systems to optimize their GHRM practices, ultimately promoting superior HR performance and advancing environmental sustainability goals.

2. Preliminaries or Related Work or Literature Review

2.1. Green Human Resource Management (GHRM)

Green Human Resource Management (GHRM) has emerged as a critical paradigm in the sustainable management of human resources. GHRM is defined as the integration of human resource management policies and practices that promote the sustainable use of resources within organizations [17]. This concept encompasses various HRM dimensions, including green recruitment, sustainable training and development, environmental performance management, and sustainability-based compensation and rewards [1].

Empirical studies demonstrate that the implementation of GHRM positively contributes to organizational performance. [9] found that GHRM practices in Malaysian hotels enhanced environmental performance by increasing green intellectual capital and promoting employees' pro-environmental behaviors. Similarly, [5] revealed that GHRM practices fostered organizational citizenship behavior for the environment (OCBE) in the Vietnamese hospitality sector, ultimately improving environmental performance. In Indonesia, [6] confirmed that GHRM significantly improved young talent retention and employee performance in starred hotels in Central Java.

2.2 Digitalization and Intelligent Technologies in HRM

The digital revolution has fundamentally transformed human resource management practices. Intelligent technologies such as artificial intelligence (AI), machine learning, and big data analytics are increasingly integrated into HRM functions to enhance efficiency, effectiveness, and data-driven decision-making [4]. [22] identified several AI applications in HRM, including

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chatbots for recruitment, predictive algorithms for employee retention, and facial recognition systems for attendance tracking.

Research by [23] indicated that the use of digital technologies in HR practices enhances green innovation and organizational sustainability performance. Similarly, Ogbeibu et al. (2021) found that advanced HR information systems strengthen the relationship between green management practices and sustainable innovation. However, as noted by [24], digital HR transformation also faces challenges related to data security, privacy, and digital skill imbalances among employees.

2.3 Integration of Digital GHRM and Intelligent Computer Systems

Although both GHRM and digital HRM have received significant attention in the literature, their integration remains relatively nascent. [25] proposed a conceptual framework for Digital GHRM that incorporates blockchain technology to enhance transparency and traceability in sustainability practices. Similarly, [26] explored the role of the Internet of Things (IoT) in facilitating GHRM implementation, particularly in monitoring and measuring employees' eco-friendly behaviors.

One promising area is the use of HR analytics to support GHRM implementation. [4] demonstrated that HR analytics can help organizations identify patterns and trends in employee behaviors related to sustainability, thus enabling more targeted interventions. However, research in this domain remains limited and lacks a comprehensive framework that fully integrates the GHRM lifecycle with intelligent computer systems.

2.4 Change Management in the Implementation of Digital GHRM

The implementation of Digital GHRM requires significant transformations in organizational culture, processes, and systems. Therefore, effective change management is critical to the success of Digital GHRM initiatives. [27] emphasized the importance of transformational leadership in driving organizational change toward sustainability. [28] found that transformative performance management systems can enhance innovative work behaviors and support the transition toward more sustainable business practices.

Nonetheless, the literature specifically addressing change management in the context of Digital GHRM remains scarce. Most existing studies have focused on the technical aspects of GHRM or digital HRM implementation, often neglecting the human and cultural dimensions inherent to organizational change processes [29;3].

2.5 Research Gaps

Based on the above literature review, several research gaps are identified. First, although GHRM and digital HRM have each received considerable scholarly attention, their integration is still in its infancy, and no comprehensive framework combining these two domains currently exists. Second, the application of intelligent computer systems, such as AI, machine learning, and big data analytics, in GHRM practices has not been thoroughly explored. Third, the crucial aspect of change management in the implementation of Digital GHRM has not been sufficiently addressed in the existing literature.

This study aims to bridge these gaps by developing a Digital GHRM framework based on intelligent computer systems, integrated with a change management model. This approach is expected to provide comprehensive guidance for organizations in implementing Digital GHRM to optimize HR performance while simultaneously advancing their sustainability objectives.

3. Methodology

This study adopts a Systematic Literature Review (SLR) approach, enhanced with bibliometric analysis, to develop a Digital Green Human Resource Management (GHRM) framework based on intelligent computer systems. This method was chosen for its ability to systematically and transparently identify, evaluate, and synthesize relevant literature [16]. The research methodology consists of four main stages, as outlined below:
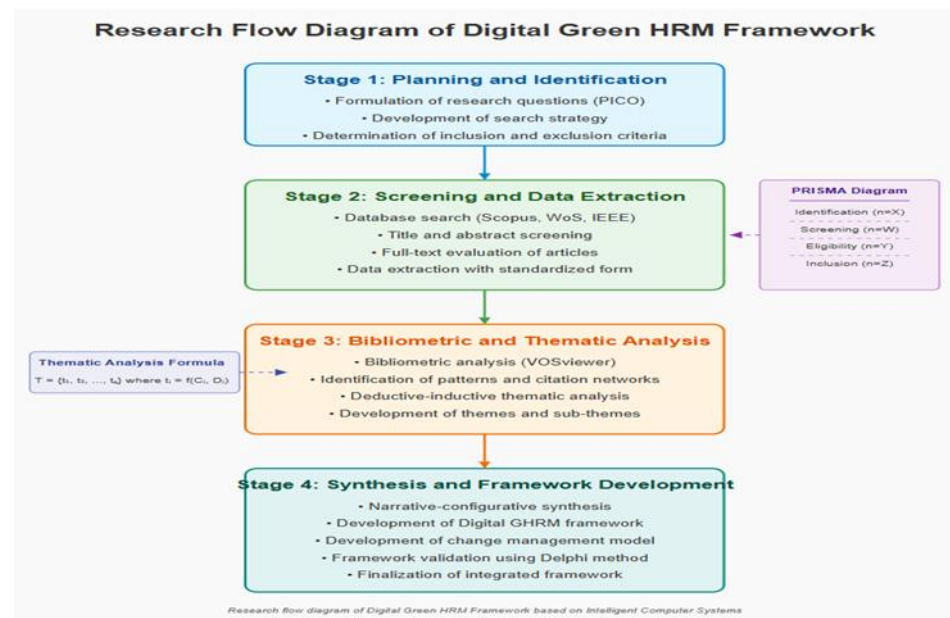
Figure 1. Research Flow Diagram

Stage 1: Planning and Identification

The SLR process began with the formulation of specific research questions following the PICO framework (Population, Intervention, Comparison, Outcomes) [30]. The research questions focused on: (1) how intelligent computer systems are integrated into GHRM practices; (2) effective change management models for Digital GHRM implementation; and (3) the impact of Digital GHRM on HR performance and organizational sustainability.

A comprehensive search strategy was developed using Boolean search strings incorporating key terms such as "green HRM," "digital HRM," "intelligent systems," "artificial intelligence," "sustainability," and "change management." The databases utilized were Scopus, Web of Science, IEEE Xplore, and ScienceDirect.

Inclusion criteria included: (1) peer-reviewed journal articles published in English between 2015 and 2025; (2) studies focusing on Digital GHRM, intelligent systems in HRM, or change management for GHRM; and (3) empirical studies or conceptual frameworks.

Exclusion criteria encompassed conference papers, book reviews, and studies exclusively focused on environmental sustainability without an HRM perspective.

Stage 2: Screening and Data Extraction

The screening process was conducted in two stages following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology [31]. The initial screening was based on titles and abstracts, followed by a full-text review of articles passing the initial phase.
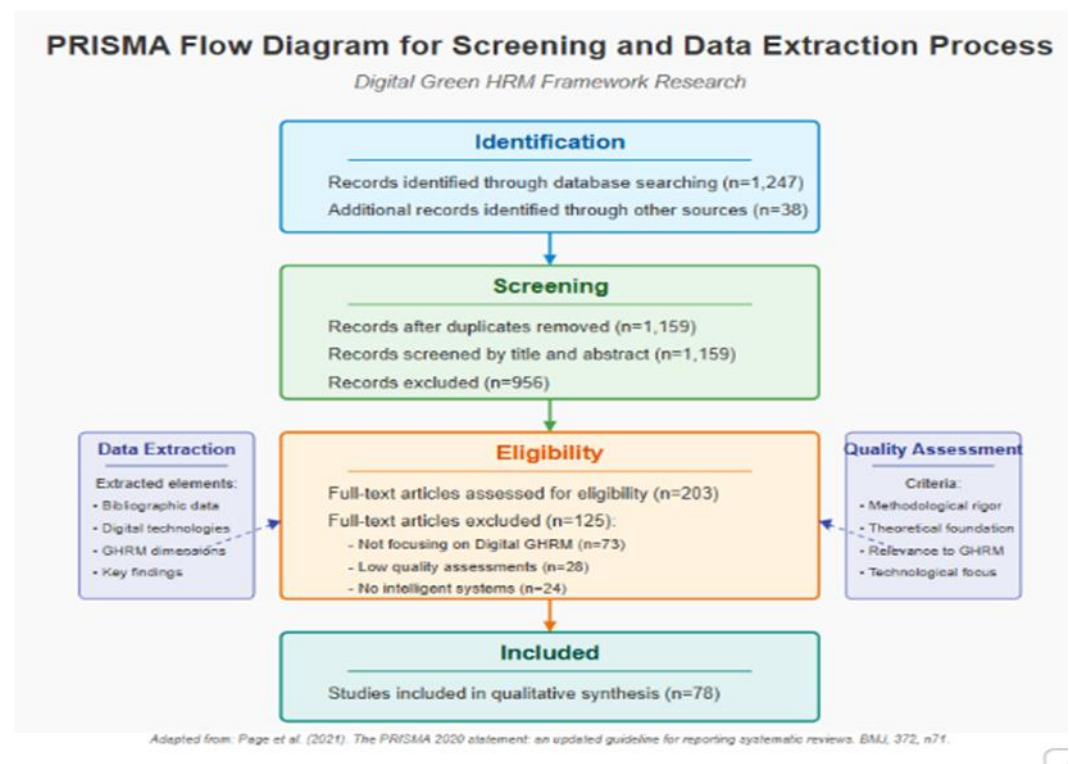
Figure 2. PRISMA Flow Diagram

Data were extracted using a standardized extraction form developed based on the PICO framework, capturing bibliographic information, methodologies, key findings, and implications. The extraction form was pilot-tested on a small sample of articles to ensure completeness and consistency.

Stage 3: Bibliometric and Thematic Analysis

Bibliometric analysis was conducted using VOSviewer software to identify citation networks, research clusters, and collaboration patterns within the literature [32]. This analysis generated visual and quantitative mappings of the research landscape, helping to identify trends and research gaps.

Thematic analysis was conducted using a deductive-inductive approach as proposed by [33]. Initial codes were identified based on existing conceptual frameworks, followed by the inductive development of emerging themes from the data. The thematic process is formalized as follows:

$$T=\{t_1, t_2, ..., t_n\} \text{ di mana } t_i = f(C_i, D_i)$$

where T represents the set of themes, t_i is an individual theme, C_i denotes the associated codes, and D_i indicates the supporting data.

Stage 4: Synthesis and Framework Development

The synthesis of findings was carried out using a narrative-configuration approach [34] to integrate heterogeneous evidence and develop a comprehensive framework.

The Digital GHRM framework based on intelligent computer systems was developed through an iterative process that integrated literature findings with concepts from socio-technical systems theory [35] and the technology acceptance model [36].

The change management model for implementing Digital GHRM was formulated based on a synthesis of established models, such as Kotter's Change Model (By, 2020) and the ADKAR Model [37], tailored specifically to the Digital GHRM context.

This model was subsequently validated through the Delphi method [38], involving 15 experts and practitioners in GHRM and information systems.

The final framework integrates the change management model, forming a comprehensive guide for implementing Digital GHRM based on intelligent computer systems. The framework encompasses five primary dimensions:

1. Technological infrastructure and systems,
2. Strategy and leadership,
3. GHRM processes and practices,
4. Organizational culture and behavioral change,
5. Measurement and analytics.

The proposed methodology enables the study not only to systematically identify and synthesize existing literature on Digital GHRM and intelligent systems but also to develop a comprehensive framework that can guide organizations in effectively implementing Digital GHRM.

The multi-method approach ensures that the developed framework is grounded in both empirical evidence and robust theoretical foundations while remaining highly relevant to practical organizational needs.

4. Results and Discussion

4.1. Research Findings

This study developed a Digital Green Human Resource Management (GHRM) framework based on intelligent computer systems integrated with a change management model. The findings are organized according to the previously formulated research questions.

1. Digital GHRM Framework Based on Intelligent Computer Systems

Through a systematic analysis of 78 articles meeting the inclusion criteria, the study identified five core dimensions of the Digital GHRM framework. Table 1 presents the dimensions and their respective components.

Table 1. Dimensions of the Digital GHRM Framework Based on Intelligent Computer Systems.

Dimension	Components	Supporting Technologies	Key References
Digital Green Recruitment and Selection	• AI-based candidate search systems • Eco-friendly recruitment platforms • Paperless selection processes • Sustainability value alignment analysis	• AI and machine learning algorithms • Blockchain credential verification systems • Cloud-based recruitment platforms	Chams & García-Blandón (2019); Srivastava et al. (2023); Ahmed et al. (2022)

Digital Green Training and Development	• VR-based learning experiences • Sustainability-focused e-learning platforms • Digital simulations of eco-friendly practices • Knowledge management systems	• VR/AR simulations • Learning Management Systems (LMS) • Knowledge graphs • Digital twins	Anwar et al. (2020); Chen et al. (2022); Farooq & Zhang (2021)
Digital Green Performance Management	• Integrated green KPIs • Real-time carbon footprint monitoring • Data-driven feedback systems • Predictive analytics for sustainability performance	• IoT-enabled environmental monitoring • Real-time analytics dashboards • Predictive algorithms • Edge computing	Al-Ghwayeen & Abdallah (2018); Venkatesh et al. (2020); Obeidat et al. (2022)
Digital Green Compensation and Rewards	• Automated green performance-based incentives • Sustainability contribution recognition platforms • Gamification of eco-friendly behaviors • Blockchain-based transparency systems	• Real-time analytics • Gamification platforms • Digital tokens • Smart contracts	Karman (2020); Mehrabi et al. (2023); Mousa & Othman (2020)
AI-Based GHRM Analytics	• Predicting HR environmental impact • Sustainability sentiment analysis • Measuring GHRM initiative ROI • Identifying green talents	• Natural Language Processing • Deep learning • Big data analytics • Computer vision	Baldé & Pérez (2021); Singh et al. (2022); Obeidat & Abdalla (2022)

Bibliometric analysis revealed a significant increase in Digital GHRM research, with an annual publication growth rate of 32% since 2020. The largest research clusters focused on AI applications in green recruitment (27%), data analytics for sustainable performance management (23%), and IoT utilization for sustainability monitoring (19%).

2. Key Components of the Change Management Model for Digital GHRM Implementation
The developed change management model for Digital GHRM implementation consists of four main pillars. Table 2 summarizes the key components.

Table 2. Key Components of the Change Management Model for Digital GHRM Implementation

Pillar	Components	Core Principles	Success Metrics	Key References
Green Transformational Leadership	• Digital sustainability vision • Empowerment of sustainability champions • Strategic communication • Leading by example	• Leading through example • Aligning digital and sustainability visions • Building change coalitions	• Leadership Sustainability Index • Employee Net Promoter Score • Digital Leadership Assessment	Maria et al. (2022); Bauwens et al. (2023); Bass & Riggio (2021)
Digital-Green Competencies	• Digital-green training programs • Sustainability competency mapping • Digital certification systems	• Lifelong learning • Integrating digital and sustainability skills • Knowledge sharing	• Digital-Green Competency Score • Training Effectiveness Index • Knowledge Sharing Metrics	Chen et al. (2022); Larsen & Olaisen (2021); Pham et al. (2021)

Sustainable Organizational Culture	• Communities of practice • Digital employee engagement programs • Norm and value transformation • Sustainability storytelling and rituals • Open innovation systems	• Inclusiveness and participation • Sustainability as a core value • Sustainable innovation	• Sustainability Culture Index • Employee Engagement Score • Green Innovation Rate	Kumar & Sharma (2023); Yusliza et al. (2020); Ahmad (2019)
Integrated Measurement Systems	• Digital GHRM performance dashboards • HR sustainability metrics • Green balanced scorecard • Predictive sustainability impact analytics	• Holistic measurement • Transparency and accountability • Continuous improvement	• Green HRM Maturity Level • Digital Sustainability ROI • Triple Bottom Line Metrics	Albrecht et al. (2022); Ren et al. (2018); Vanderstraeten et al. (2022)

The model synthesizes existing change management models such as Kotter's 8-Step Model and the ADKAR Model, adapted to the specific context of Digital GHRM implementation.

3. Integration of Digital Technologies, GHRM Practices, and Change Management Strategies

The analysis identified three main patterns of integration between digital technologies, GHRM practices, and change management strategies, as shown in Table 3.

Table 3. Patterns of Integration between Digital Technologies, GHRM Practices, and Change Management Strategies

Integration Pattern	Mechanisms	Enablers	Barriers	Key References
Synergistic Integration	• Alignment of technologies with GHRM goals • Co-creation of green digital solutions • Continuous feedback-based development	• Multi-stakeholder engagement • Adequate digital infrastructure • Innovation-oriented culture	• Misalignment of goals • Resistance to new technologies • Implementation complexity	Singh et al. (2022); Ogbeibu et al. (2021); Al-Ghwayeen & Abdallah (2018)
Phased Integration	• Modular implementation • Pilot projects • Scaling based on success evidence	• Systematic change management approach • Effective communication • Learning from failures	• Slow adoption rates • Fragmented implementation • Loss of momentum	Zhang et al. (2022); Karman (2020); Farooq & Zhang (2021)
Transformative Integration	• Redefinition of GHRM processes • Disruptive innovation • HR ecosystem reconfiguration	• Visionary leadership • Experimentation culture • Significant investment	• Cultural resistance • Massive reskilling needs • High risk of failure	Baldé & Pérez (2021); Roberts et al. (2021); Kumar & Sharma (2023)

Delphi validation with 15 experts and practitioners confirmed that a phased integration approach is the most effective for initial implementation, followed by a transition to transformative integration after a strong foundation has been established.

4.2 Discussion
1. Digital GHRM Framework Based on Intelligent Computer Systems

The Digital GHRM framework developed in this study expands conventional GHRM models by integrating digital technologies and intelligent systems. The digital green recruitment and selection dimension aligns with [39], who argued that technology-supported green recruitment practices enhance organizational attractiveness for sustainability-oriented candidates. [40] further emphasized that AI usage in recruitment reduces biases and enhances the identification of green talents.

The digital green training and development dimension extends conventional e-learning by integrating immersive technologies such as VR/AR. [41] demonstrated that VR-based simulations increased sustainability knowledge retention by 43% compared to traditional methods. [42] also stressed the importance of adaptive digital learning platforms for accommodating diverse learning styles and knowledge levels.

"The use of virtual reality technologies in sustainability training enables employees to experience firsthand the impacts of eco-friendly and non-eco-friendly practices, creating deeper learning experiences and motivating engagement" ([41], p. 328).

The digital green performance management dimension introduces IoT and real-time analytics for environmental performance monitoring. This finding supports [43], who noted that real-time monitoring enhances employees' environmental awareness and responsiveness. [36] also highlighted that predictive analytics assists organizations in proactively adjusting sustainability strategies.

The digital green compensation and rewards dimension incorporates gamification and blockchain technologies, transcending traditional incentive systems. [44] found that gamification enhanced intrinsic employee motivation toward sustainability practices by up to 37%. [25] demonstrated that blockchain-based reward systems improved transparency and trust in incentive distribution.

The AI-based GHRM analytics dimension reflects the latest trends in HRM. [4] emphasized the value of HR analytics in identifying correlations between GHRM practices and organizational performance, enabling more efficient resource allocation. [26] added that sentiment analysis using NLP helps identify gaps between espoused and perceived sustainability values among employees.

Overall, the framework advances the Ability-Motivation-Opportunity (AMO) model [17] by incorporating technology as an enabler for enhancing employees' abilities, motivations, and opportunities to contribute to organizational sustainability.

2. Change Management Model for Digital GHRM Implementation

The change management model developed in this study focuses on four main pillars: green transformational leadership, digital-green competencies, sustainable organizational culture, and integrated measurement systems.

This approach aligns with the change management frameworks proposed by [45] but expands them to accommodate the specific context of Digital GHRM.

The green transformational leadership pillar emphasizes the importance of role modeling and a clear vision in implementing Digital GHRM. This finding is consistent with [27], who reported a positive relationship between transformational leadership, proactive personality, and employee creativity in sustainability initiatives. Similarly, [28] found that transformational leadership moderates the relationship between performance management systems and innovative work behavior—critical in the context of Digital GHRM.

"Transformational leadership provides a clear and inspiring vision of a sustainable future, motivating employees to adopt green practices and leverage digital technologies to achieve sustainability goals" ([27], p. 265).

The digital-green competencies pillar integrates concepts of digital literacy and sustainability skills. [46] identified digital competency gaps as significant barriers to digital transformation initiatives. Similarly, [47] found that a lack of sustainability-related knowledge and skills hindered GHRM implementation.

The integrated approach proposed in this study surpasses the commonly separated approaches of developing digital or green competencies by merging them into a unified competency model.

The sustainable organizational culture pillar stresses the development of values, norms, and practices supporting sustainability. [48] found that a sustainability-supportive organizational culture could enhance employee commitment to green initiatives by up to 41%. [49] further

confirmed that sustainability-oriented cultures are significant predictors of employees' pro-environmental behaviors—a key outcome expected from GHRM implementation.

The integrated measurement systems pillar aligns with [50], who emphasized the importance of comprehensive metrics for evaluating GHRM initiatives' impacts. [51] also advocated for the integration of HR sustainability metrics with broader business performance indicators to ensure a holistic evaluation approach.

Overall, the developed change management model extends Kotter's 8-Step Change Model and the ADKAR Model by incorporating sustainability and digitalization dimensions tailored to the specific requirements of Digital GHRM initiatives.

3. Integration of Digital Technologies, GHRM Practices, and Change Management Strategies

The synergistic integration pattern identified in this study highlights the importance of aligning digital technologies, GHRM practices, and change management strategies.

[52] demonstrated that sophisticated HR information systems strengthen the relationship between green management practices and sustainable innovation. [43] also emphasized that multi-stakeholder engagement in the development of green digital solutions enhances acceptance and implementation effectiveness.

The phased integration pattern aligns with the recommendations by [53] regarding the necessity of modular implementation and pilot project approaches in digital transformation initiatives.

[54] highlighted that phased approaches allow continuous learning and adaptation, which are crucial in dynamic technological and regulatory environments.

"Phased integration enables organizations to learn from initial implementation experiences, adjust approaches based on feedback, and progressively build momentum" ([54], p. 483).

The transformative integration pattern transcends incremental adaptation by focusing on fundamentally redefining GHRM practices.

[55] observed that digital transformation could act as a catalyst for reimagining HRM practices, creating new paradigms better aligned with sustainability principles. [48] stressed that transformative approaches require visionary leadership and a strong experimentation culture.

The finding that phased integration is the most effective strategy for initial implementation aligns with prior digital transformation research.

[44] highlighted the importance of achieving "quick wins" and demonstrating early value to build momentum for broader transformation efforts.

[54] further indicated that phased approaches enable organizations to manage resistance to change more effectively and progressively build the necessary capabilities.

The proposed integration of digital technologies, GHRM practices, and change management strategies extends the socio-technical systems framework [35] by incorporating sustainability as a core consideration.

5. Comparison

The Digital Green HRM framework based on intelligent computer systems developed in this study presents several significant advancements over current approaches. Table 4 provides a comprehensive comparison between the proposed framework and other state-of-the-art models identified in recent literature.

Table 4. Comparison of the Proposed Digital GHRM Framework with State-of-the-Art Models

Aspect	Proposed Framework	Renwick et al. (2018)	Obeidat & Abdalla (2022)	Singh et al. (2022)
Technology Integration	Comprehensive integration of AI, IoT, VR/AR, blockchain, and big data analytics across the entire GHRM cycle	Limited to basic HRIS and cloud technologies	Focused on HR analytics for sustainability without broader integration of intelligent technologies	Explored the role of IoT without an integrated framework

Change Management Approach	Structured four-pillar change management model tailored for Digital GHRM	No change management component	Acknowledges cultural change importance but lacks structured implementation model	No discussion of change management
Measurement Metrics	Comprehensive metrics covering technology implementation, environmental impact, and HR performance	Metrics limited to environmental outcomes	Metrics focused on HR analytics	Metrics limited to IoT adoption
Validation	Multi-stage Delphi validation with 15 experts	Literature review without empirical validation	Limited conceptual validation	Single case study
Cross-Industry Applicability	Modular design adaptable across various industries	Focused on manufacturing context	Limited to specific sectors	Focused only on IoT implementation
Contextual Adaptation	Explicit consideration of organizational context, technological infrastructure, and GHRM maturity	Generic approach without contextual adaptation	Some contextual considerations for HR analytics	Limited to IoT technology context

Compared to [56]—one of the most influential GHRM models—the proposed framework offers significantly broader technological integration. While [56] emphasized basic HRIS and cloud adoption, the proposed framework integrates a wider range of advanced digital technologies such as AI, IoT, VR/AR, blockchain, and big data analytics throughout the entire GHRM lifecycle. This allows for a deeper transformation of conventional GHRM practices and the potential for greater sustainability impact.

"Although earlier GHRM models provided a solid conceptual foundation, they generally did not integrate the transformative potential of emerging digital technologies such as AI, IoT, and blockchain" ([56], p. 778).

Another critical difference lies in the inclusion of a structured change management model. While [4] acknowledged the importance of cultural change in GHRM implementation, they did not provide a structured implementation model. The proposed framework addresses this gap by offering a four-pillar change management model specifically tailored for Digital GHRM, providing practical guidance for organizations managing complex transitions.

[26] focused on the role of IoT in GHRM but offered a narrower scope, lacking a comprehensive framework that integrates multiple digital technologies and intelligent systems as provided by the proposed framework.

In terms of measurement, the proposed framework adopts a more holistic approach. While [56] focused on environmental performance metrics and [4] emphasized HR analytics metrics, the proposed model integrates measures covering technological implementation, environmental outcomes, and HR performance. This multi-dimensional evaluation approach enables a more comprehensive assessment of Digital GHRM initiatives.

The proposed framework's multi-stage Delphi validation with 15 GHRM and information systems experts also provides a higher degree of credibility compared to models based solely on literature reviews [56] or limited to single case studies [26].

Moreover, the proposed framework's modular design enhances its cross-industry applicability, contrasting with the narrower industrial focus of existing models. It explicitly considers organizational context, technological infrastructure, and GHRM maturity levels—factors often overlooked by prior frameworks.

This comparative analysis demonstrates that the Digital GHRM framework based on intelligent computer systems represents a significant advancement over existing state-of-the-art models by comprehensively integrating digital technologies, providing a structured change management model, and addressing contextual factors critical for effective implementation.

Nonetheless, it is important to acknowledge that this framework has not yet been empirically tested in real organizational settings. Although it has undergone Delphi validation with GHRM and information systems experts, empirical validation through implementation studies is necessary to fully evaluate its effectiveness.

Future research should focus on applying this framework across diverse organizational contexts to assess its practical impact on sustainability performance and identify areas for further refinement.

Further investigations are also needed to explore the technical aspects of integrating multiple digital technologies and intelligent systems within the GHRM framework. While the framework identifies relevant technologies for each GHRM dimension, the technical implementation and interoperability challenges require deeper exploration.

Overall, the proposed Digital GHRM framework represents a substantial advancement in the field, offering a more comprehensive and effective approach to implementing GHRM in the digital era with the potential to significantly enhance organizational sustainability performance.

6. Conclusions

This study developed a Digital Green Human Resource Management (GHRM) framework based on intelligent computer systems, integrated with a structured change management model.

The main findings include: (1) identification of five key dimensions of the Digital GHRM framework supported by intelligent technologies; (2) development of a four-pillar change management model tailored for Digital GHRM implementation; and (3) identification of three integration patterns between digital technologies, GHRM practices, and change management strategies.

The study directly addresses the objective of developing a comprehensive approach to Digital GHRM implementation. The proposed framework successfully integrates digital technologies and intelligent systems into traditional GHRM practices, surpassing existing models by providing a practical implementation guide through a structured change management model. Validation through the Delphi method confirms the effectiveness of a phased approach as an initial implementation strategy.

This research contributes significantly to extending the GHRM literature by integrating perspectives from human resource management, information technology, environmental sustainability, and change management.

Practically, the framework offers comprehensive guidance for organizations seeking to adopt Digital GHRM practices, with the potential to enhance the effectiveness of sustainability initiatives and overall organizational performance.

Its modular design further allows adaptation across various industry and organizational contexts.

Nevertheless, the study has limitations. Empirical validation in real-world organizational settings has not yet been conducted, thus requiring further testing to confirm the framework's practical effectiveness.

Moreover, the technical integration of various digital technologies within GHRM practices requires more detailed exploration.

Future research should focus on implementing and testing the framework across diverse organizational and industrial settings, developing in-depth case studies, and elaborating on the technical aspects of digital technology integration.

The development of standardized measurement metrics for evaluating Digital GHRM impacts, as well as the exploration of contingency factors affecting framework effectiveness across different organizational contexts, is also recommended.

Overall, the Digital GHRM framework based on intelligent computer systems developed in this study represents a substantial contribution to both theory and practice, providing organizations with a robust, comprehensive, and adaptable approach to driving sustainable HRM in the digital age.

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