

Artificial Intelligence Enabled Green Human Resource Management and Environmental Sustainability: An Empirical Analysis of Pakistani Organizations

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ABSTRACT: The growing environmental challenges confronting organizations have increased the importance of integrating sustainable human resource practices with advanced digital technologies. This study examines the impact of Green Human Resource Management (GHRM) practices green recruitment, green training and development, green compensation and rewards, and employee empowerment on organizational environmental sustainability, while investigating the moderating role of Artificial Intelligence (AI). Data were collected from employees working in organizations across multiple sectors in Pakistan, and Structural Equation Modeling (SEM) using WarpPLS 8.0 was employed to test the proposed relationships. The findings reveal that green training and development is the strongest predictor of environmental sustainability, followed by green compensation and rewards, green recruitment, and employee empowerment. Furthermore, AI significantly strengthens the relationship between GHRM practices and sustainability outcomes by enhancing HR analytics, monitoring efficiency, predictive accuracy, and environmentally responsible decision-making. The study contributes to the emerging literature on AI-enabled sustainable HRM by providing empirical evidence on the integration of intelligent technologies with green HR practices in developing economies. The findings offer practical insights for policymakers, HR managers, and organizational leaders seeking to implement AI-driven sustainability strategies that improve environmental performance and long-term organizational sustainability.

Keywords: Green Human Resource Management (GHRM), Artificial Intelligence (AI), Environmental Sustainability, Sustainable Human Resource Management, Organizational Sustainability.

I. INTRODUCTION

Sustainability as an issue has shifted in modern business settings to become core strategic obligation in organizations [1]. This change is more relevant in the field of Human Resource Management (HRM), where green HR practices have become a necessity in promoting the corporate sustainability agendas [2]. Green HRM is a continuum of environmentally conscious programs such as the green recruitment, green training, green compensation and rewards and green empowerment that work to reduce the environmental impact of organizational operations. The practices not only help to create an environmentally conscious work culture

but also encourage sustainable employee practices that will help achieve greater environmental goals [3]. Although there is an increasing recognition of their benefits, green HR practices are used differently and with varying effectiveness in various organizations [4]. One of the crucial preconditions of this difference could be the implementation of Artificial Intelligence (AI) in HRM processes. The transformational potential of AI in enhancing efficiency, accuracy, and data-based decision-making has potential to benefit the environment of HR practices. AI can be used as a moderating force to enhance the beneficial impact of green HR practices on the environmental sustainability by automating repetitive operations, maximizing resource benefits, and providing actionable insights [5, 6].

However, the overlap of AI and green HRM is still a new area of study, and few instances of empirical research investigate the role of AI in moderating the connection between green HRM practices and environmental sustainability [7, 8]. To fill this research gap, the current study examines the moderating aspect of AI in the nexus between green HR practices, namely, green recruitment, green training, green compensation and reward and green empowerment, on one hand, and environmental sustainability, on the other hand [9]. The research aims at presenting a subtle insight into the ways AI-based solutions can be used to improve the effectiveness and effectiveness of sustainability-focused HR practices so that organizations could deliver on their environmental objectives more successfully. In addition to its theoretical contribution, this study provides immense practical implications to organizations that seek to integrate the technological innovation to sustainable management practices. The study emphasizes the need to be responsible in AI deployment in the context of HRM and provides the opportunity to build sustainability-oriented cultures and improve corporate orientation towards the Sustainable Development Goals (SDGs). In turn, this study contributes to the academic debate on the intersection between AI and sustainable HRM by providing a valuable contribution to the field of academia and practice.

This study is theoretically anchored in the Ability–Motivation–Opportunity (AMO) framework, complemented by the Resource-Based View (RBV) and Socio-Technical Systems (STS) theory. From an AMO perspective, green HR practices enhance employees' environmental abilities (through training), motivation (through green rewards), and opportunities (through empowerment), thereby improving sustainability outcomes. RBV further conceptualizes artificial intelligence as a strategic organizational resource that strengthens these HR capabilities and enables sustained competitive advantage in environmental performance. In addition, STS theory explains how the interaction between advanced technologies (AI) and social systems (HR practices) jointly produces ecological value. By integrating these frameworks, the study provides a robust theoretical foundation for examining AI as a moderator in the green HRM–environmental sustainability relationship. Hence, there are three important contributions in this study. Theoretically, it expands the literature on green HRM because it empirically proves the moderating role of artificial intelligence with an integrated AMO–RBV–STS perspective. It presents AI as a quantifiable socio-technical moderator as opposed to a situational setting, which is assessed by SEM with the WarpPLS. In practice, it offers evidence-based advice to organizations in the emerging economies and how to use AI-based HR systems to enhance environmental sustainability results.

II. LITERATURE REVIEW

1. GREEN HR PRACTICES

The topic of green human resource practices has, in recent years, received considerable scholarly interest as organizations strive to make their operations meet the goals of sustainable development [10]. Such practices include green recruitment, green training, green compensation/reward, and green empowerment, where each practice is meant to reduce the environmental impact of human resource practices. Green recruitment is hiring and hiring employees who show concern towards the environment and are interested in sustainability, and often use digital solutions to minimize the use of paper and physical travel. It is a green training that aims at sensitizing employees on sustainable practices and promoting environmentally friendly behaviors in the workplace [11]. Green compensation/reward systems are designed in such a way that they

can encourage sustainable practices by tying the rewards and recognition to environmentally sustainable practices. Indicatively, an employee can be given a bonus or other incentives based on his or her role in ensuring that the carbon footprint of the organization is reduced [12]. Green empowerment involves giving staff the freedom and resources to introduce sustainable operations in their day-to-day operations to build a culture of sustainability across the organization [13].

2. *IMPACT OF GREEN HR PRACTICES ON ENVIRONMENTAL SUSTAINABILITY*

The effectiveness of green HR practices in encouraging the sustainability of the environment is not new. According to the empirical research, the environmental performance of organizations implementing holistic green HR practices can improve significantly. These gains are explained by the development of a friendly organizational culture that is oriented towards the environment and encourages eco-friendly behaviors among the employees [14]. Besides, green HR practices may lead to a better image of an organization, making it more appealing to the environment-conscious talents and consumers [15]. However, the degree of green HR practices can differ significantly in respect to the organization's commitment to sustainability and the relevant strategies used [4]. As an example, although green recruitment and training may lead to increased awareness and sustainability knowledge, its performance depends on the continuation and promotion of the values in the organization. Likewise, the effectiveness of green compensation/reward and empowerment programs depends on how these practices are aligned with the organization and its culture in general [16].

3. *GREEN RECRUITMENT AND ENVIRONMENTAL SUSTAINABILITY*

This is because green recruitment practices are central in determining the environmental sustainability in an organization, with an overwhelming positive impact to both the internal operations and the overall environmental effect. Organizations actively recruit individuals who have proved to be committed to the environment by incorporating sustainability criteria in recruitment procedures [1]. Such a conscious choice of the environmentally conscious individuals not only matches the workforce with the sustainability goals of the organization but, also promotes the culture of environmental stewardship in the workplace. With sustainability-oriented employees coming to the company, new ideas, practices, and behaviors are brought on board that help limit the environmental impact and advance sustainable behaviors in any aspect of operations. Green recruitment enables organizations to bring a sense of environmental values to their workforce and establish a force that will act in favor of environmental sustainability projects [17]. Further, green recruitment does not just impact on the organization alone, but on the wider society and environment. Organizations help to create a talent pool that is more and more sensitive to environmental issues and is capable of responding to them after repeatedly hiring candidates, who will reflect the principles of sustainability [18]. As the new generation of environmental conscious people have taken up key posts in the organizations, they are on the forefront to champion programs that will reduce carbon footprints, reduce waste, and promote sustainable practice along the supply chains. These initiatives do not only improve the environmental performance of the respective entities concerned but also create a ripple effect on the industry, with both rivals and partners reacting by implementing sustainability-related practices [19]. Green recruitment, in turn, is the driver of environmental change to make a positive difference that will lead to a more sustainable future, both on the outside and internal to the organizations [20, 21]. Therefore, the hypothesis below is suggested.

- H1: Green recruitment has positive impact on environmental sustainability.

4. *GREEN TRAINING AND ENVIRONMENTAL SUSTAINABILITY*

Green training has an immense efficacy as it increases the environmental sustainability of the organizations by creating a labor force that has the knowledge, skills and learning capabilities that can positively influence the change [21, 22]. Organizations can help employees to understand the specifics of environmental issues and implement sustainable behavioral patterns in their daily operations by investing in elaborate training programs focused on environmental practices. This kind of training increases environmental awareness levels and provides the staff with practical tools and techniques that will help them

incorporate the sustainability principles into the work processes [23]. The more the employees are able to practice sustainable practices, the more they attract resource efficiency, reduction of wastes and diminished effects of environmental impact on the different operations of an organization. As such, green training is a primary aspect towards the development of an environmental responsibility culture in organizations and, as such, the general commitment towards achieving the goals of sustainability [24]. Moreover, green training does not only apply to the individual organizations, but to the general societal and environmental situations, and has an overall positive impact on the global level. Investing in and concentrating on the green training programs, organizations become increasingly key players in the creation of talent pools that are ready to meet the newly arising environmental issues. The employees who undergo such training do not only spearhead the sustainability activities in their respective organizations, they also act as custodians of the environment in their localities and industries [25]. Green training programs give employees the knowledge and skills they need to be creative and develop sustainable solutions to complicated environmental issues, as a result, causing them to adopt sustainable practices in various sectors [26]. In this regard, green training becomes a powerful tool that will help to implement environmental sustainability and enable people to make a substantial change and create a more sustainable environment to future generations [27]. Therefore, it suggests the following hypothesis.

- H2: Green training has positive impact on environmental sustainability.

5. GREEN REWARD/COMPENSATION AND ENVIRONMENTAL SUSTAINABILITY

The concept of green reward and compensation systems provides an upcoming prospect of incentivizing and rewarding environmentally responsible behavior in organizations, which in turn leads to the culture of sustainability and the creation of positive environmental impacts. Through reward and compensation systems, organizations will be able to identify and reward actions and accomplishments by employees that are environmentally conscious through incorporation of green criteria in their reward and compensation programs. This not only provides a practical demonstration of the sustainability commitment of the organization itself but also encourages employees to become proactive participants in the practices and trends related to green [28]. Employees are motivated to embrace sustainable practices in their daily working habits through reward schemes like bonuses, promotions or eco-friendly behavior recognition initiatives, which translate into the minimization of resources, cutting down of carbon footprints, and overall environmental performance [27]. Therefore, the green reward and compensation systems are central to aligning the behaviors of individuals with the objectives of organizational sustainability, and this will result in improved environmental sustainability within and outside the organizational context [29]. Moreover, the green reward and compensation systems influence the situation not only in the context of the organization but also in more general social and environmental spheres. Organizations can help in the spread of sustainable practices in the industries and communities by incentivizing environmentally responsible behavior among employees. When employees are rewarded and recognized due to their green practices, they become the proponents of sustainability at the workplace and beyond the work environment, influencing others to develop similar green behaviors [30]. Besides, green reward and compensation systems may be used as a means of ensuring innovation and creativity towards coming up with sustainable solutions to the intricate environmental problems. Relating rewards to environmental performance measures or performance, organizations motivate employees to seek new methods of finding how to impact the environment less and promote never-ending advancements in sustainability practices. In this respect, green reward and compensation systems become one of the potent instruments to encourage environmental sustainability, develop the culture of the environmental responsibility, and introduce constructive change on the global level [31, 32]. Hence, this leads to the following hypothesis.

- H3: Green Reward/Compensation has positive impact on environmental sustainability.

6. GREEN EMPOWERMENT AND ENVIRONMENTAL SUSTAINABILITY

The green empowerment programs are the initiatives that contain the possibilities to trigger strong positive effects on the environmental sustainability of organizations through the sense of ownership,

participation, and responsibility among the employees. Employees can also be empowered to become members of green efforts and decision-making and contribute to an invaluable resource of various perspectives, ideas, and talents committed to promoting sustainability objectives [33]. Organizational structures can also use the synergy of their human resources to effect positive changes through participation by workers in environmental sustainability practices by establishing employee green teams, participative decision-making units, and skill-sharing and leadership in sustainability activities[34]. Employees who feel empowered will be more willing to own sustainability programs and enact creative solutions, and promote environmentally friendly practices both in their assignments and across the organization. Additionally, green empowerment is an opportunity to create a culture of environmental consciousness and develop a feeling of mutual devotion to sustainability among the employees[35]. As a result, green empowerment is an opportunity to create a culture of environmental consciousness and develop a feeling of mutual devotion to sustainability among the employees [29]. Moreover, the effect of green empowerment is not restricted to the organizational level only, but also the society and the environment at large, since it helps to promote and embrace sustainable practices on a more massive scale. With the empowered employees being placed in the lead in the sustainability initiatives, they would be the agents of environmental care in their communities, industries, and networks. Empowered employees enhance the effects of organizational sustainability and create a positive change in the external environment through active involvement in green initiatives, promoting sustainable organizational policies, and working with external stakeholders [36]. Also, green empowerment programs can be used as a tool to foster inclusivity, diversity, and social equity in sustainability programs and, thus, make environmental gains evenly distributed amongst all stakeholders [37]. Based on this, green empowerment can be viewed as a powerful tool of environmental sustainability, as the mobilized effect of empowered employees will make a transformative change towards a more sustainable future [24, 38]. Hence, this leads to the following hypothesis.

- H4: Green Empowerment has positive impact on Environmental Sustainability.

7. ROLE OF ARTIFICIAL INTELLIGENCE IN HRM

AI has become a disruptive technology in various aspects of businesses, such as human resource management (HRM). The AI technologies enable the HR functions to automate the routine processes, optimize the management of resources, and provide the evidence-based information that can guide the strategic decisions [39]. The field of green HR practices provides the benefit of unmatched opportunities to make the practice more effective and contribute to the environmental sustainability through AI [8] the recruitment systems that are based on AI can automatize the hiring process, so the need to travel physically and use papers to conduct multiple interviews and apply online can be minimized. This does not only enhance efficiency, but also reduces the carbon footprint of the organization [40, 41]. Equally, AI-based e-learning tools have the potential to provide scalable and flexible training services to replace face-to-face sessions that use resources in large numbers with online courses that can be accessed anytime and anywhere [42]. In addition, AI can also be used to improve green compensation and reward systems because it may offer real-time data regarding the performance of employees and sustainability indicators, thus allowing offering more eco-friendly incentives with greater accuracy and timeliness [12, 43]. Besides, AI can promote green empowerment providing the means and platforms allowing employees to track and manage their ecological footprint, which will contribute to a continuous improvement and development of greener practices [13]. With reference to this study, Artificial intelligence in the participating organizations is applied practically in several digital applications that have an HR nature. Resumé screening, shortlisting of candidates using sustainability-related competencies, and minimization of paper-based and travel-intensive methods of hiring are automated using AI-enabled recruitment systems. In training and development, the use of AI-based e-learning stands out as a mechanism that offers employees customized sustainability training modules through which employees can access environmentally oriented learning content at any time and place. The performance management also makes use of AI in terms of real-time analytics which monitor the activity of the employees in the green initiatives, energy saving practices and waste reduction

activities. Moreover, AI-enhanced dashboard and feedback solutions enable employees of the organization as they can keep track of their ecological footprint and take an active part in the programs of organizational sustainability.

8. INTERPLAY BETWEEN AI AND GREEN HR PRACTICES

Even though the joint conceptualization of artificial intelligence (AI) and green human resource practices can bring forth a number of advantages, the mutual connection between the two concepts has not been sufficiently studied yet [7]. The existing research presupposes that AI can lead to a better performance of green HR practices because of the high level of analytics, automation of operations, and enhanced communication and cooperation [5, 44]. However, there is still little empirical data defining the specific mechanisms that AI mediates between the relationship of green HR practices and environmental sustainability [45]. Green recruitment aims at hiring and attracting candidates who are environmentally conscious and sustainability-oriented. Through the application of AI technologies, organizations can automate the recruitment process, minimize the necessity of physical traveling and use paper-based documents, and achieve a better fit between the applicant and the organizational sustainability goals. This makes the impact of green recruitment in enhancing environmental sustainability to increase [46, 47]. Hence, it can be stated that the positive impact of green recruitment on environmental sustainability is stronger when AI is utilized in the recruitment process.

Green training entails the training of the employees on matters of sustainability and promoting commitment to enthusiasm towards the environment. AI-based e-learning platforms are capable of delivering customized and scalable training solutions, replacing the resource-intensive face-to-face training with the, at all times and places online training module [42]. This can maximize the effectiveness of green training in promoting environmental sustainability, as the beneficial effect of green training on environmental sustainability is doubled when AI is used during the training [48, 49].

Green compensation and reward systems are formulated with an objective of motivating sustainable behaviors by integrating rewards and recognition with environmentally sound behaviors. AI will be able to strengthen these systems by giving real-time information on the work of employees in performance and sustainability indicators, which will allow rewarding environmentally responsible behaviors more accurately and timely. This will be able to enhance the efficacy of green compensation and reward in encouraging environmental sustainability [50, 51] That is how the favorable influence of green compensation and reward on environmental sustainability is boosted as AI is incorporated in the compensation and reward procedure.

Green empowerment is defined as the delivery of control and resource that helps employees to implement sustainable practices in the daily activities [52]. In order to be empowered in this way, AI may provide the means and the platforms that will enable employees to track and control their ecological footprint, thus encouraging constant growth and development of sustainable processes [53]. Such an ability makes green empowerment more useful in enhancing environmental sustainability because the positive effects of empowerment on sustainability will be increased in case AI is incorporated into the empowerment process [50]. Moreover, the use of AI in green HR has significant prospects of improving the effectiveness of this activity in improving environmental sustainability [43, 53]. In examining how AI can moderate the relationship between the environmental sustainability and green HR practices, the study will meaningfully contribute to the literature of understanding how AI can play the role of a facilitator to organizational sustainability goals.

Therefore, it is theorized that artificial intelligence has a positive moderating effect on all green HRMs-sustainability relationships due to its ability to increase the degree of precision, scalability, and behavioral reinforcement mechanisms in diverse HR functions. AI-based automation will minimize resource inefficiencies, predictive analytics will enhance the precision of decisions, and real-time monitoring will strengthen environmentally sound behaviors. Instead of replacing human judgment, AI supplements HR systems with making sure that their execution of green practices remains consistently applied, which

enhances their sustainability influence in the domains of recruitment, training, compensation, and empowerment. Hence, this postulates the following hypothesis.

- H5: AI moderates the relationship between green recruitment and environmental sustainability.
- H6: AI moderates the relationship between green training and environmental sustainability.
- H7: AI moderates the relationship between green compensation/reward and environmental sustainability.
- H8: AI moderates the relationship between green empowerment and environmental sustainability.

9. RESEARCH FRAMEWORK

The proposed framework assumes that green HR practices directly influence environmental sustainability outcomes by shaping employee behaviors and organizational routines. Artificial intelligence is modeled as a moderating variable that enhances these relationships by improving process efficiency, decision accuracy, and behavioral reinforcement. The framework assumes additive and synergistic effects rather than substitution effects, whereby AI complements rather than replaces human-driven sustainability initiatives.

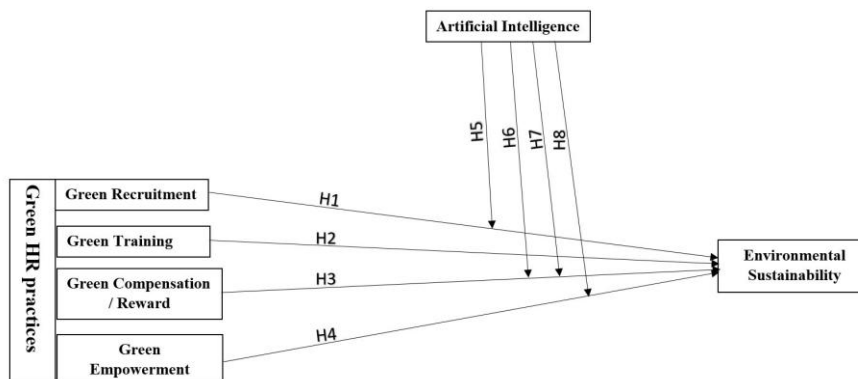


FIGURE 1: Research framework.

III. METHODOLOGY

This quantitative study assesses the moderation of artificial intelligence in the association amid green human resource practices and environmental sustainability in Pakistani organizations. Through the purposive sampling technique, 323 valid responses were received in 450 distributed questionnaires by employees who have experience in AI and green HRM. The four operationalized dimensions of green HR practices are recruitment, training, empowerment, and compensation/reward adopted the scale validated by [54], whereas environmental sustainability was gauged by seventeen items adopted from [55], and AI by ten items used by [56]. The operationalization of artificial intelligence was as a perceptual construct that encompassed the evaluation of AI integration in the HR functions by the employees. The scale was used to determine the degree to which AI-assisted systems are applied to screening of recruitment, delivery of digital training, tracking of performance, and sustainability analytics. This method of perception is suitable since the employees are these individuals who work directly with AI-based HR systems and can best judge their functional effects on HR practices. All constructs were found to have good levels of reliability and validity as evaluated through standard process of scaling. Regression analysis was done using WarpPLS 8.0 as part of a structural equation modeling. Moreover, the research integrity was ensured by obtaining ethical approval and informed consent and procedural fixes like assurance of anonymity and psychological aloofness of constructs were also used to deal with the possibility of common method bias. Harman's single-factor test showed the first factor explained 34% of variance (<50%). Full collinearity VIF values were below 3.3, confirming absence of pathological collinearity. A marker variable approach indicated no significant coefficient inflation. These results suggest common method bias is unlikely to threaten validity.

IV. DATA ANALYSIS

The following table shows demographic statistics of the respondents of the study that are employees of SMEs and large organizations. The distribution reveals that out of 450 questionnaires distributed to the respondents, 323 were received correctly with a response rate of 71.77%. The questionnaires were distributed to multiple organizations, with five employees selected from each organization, including HR managers, other managerial staff, and general employees. The responses comprised 47 HR Managers (14.5%), 106 Other Managers (32.8%), and 170 Other Employees (52.6%), totaling 323 respondents. As per organizational type, 71.1 % organizations were from the manufacturing sector, and 28.9% were from the services sector. The responses were nearly evenly split as per geographical area, with 52.2% respondents from Lahore and 47.8% respondents from Faisalabad. Hence, the statistics show that the data has been collected from diverse population across different managerial levels and organizational types, with a slightly higher participation from the manufacturing sector and balanced input from the key cities of Lahore and Faisalabad. The organizations were a combination of the small and medium-sized enterprises (SMEs), together with large organizations based in the manufacturing and service industries. The SMEs used comparably simple AI-based HR applications (digital recruitment sites, online training systems) but the bigger companies have noted having much more advanced AI usage. The variety in the size of the organizations makes the results more robust as it covers a range of AI adoption and green HR implementation in the Pakistani organizational environment.

Table 1. Demographic statistics.

Designation	Frequency	Type of Organization	Frequency	Cities	Frequency
HR Manager	47	Manufacturing	64	Lahore	47
Other Managers	106	Services	26	Faisalabad	43
Total	323				

1. RELIABILITY STATISTICS

A full description of the reliability and convergent validity of the constructs used in this study evaluated with Factor loadings, Cronbach's Alpha and Average Variance Extracted (AVE) is presented in the table below. All factor loadings exceed the recommended threshold of 0.70, ranging from 0.79 to 0.91, indicating strong indicator reliability across all constructs. The majority of items load above 0.80, demonstrating that the observed variables are strong representatives of their respective latent constructs. The absence of weak or cross-loading indicators suggests that no item removal is required and the reflective measurement model is well specified. The Green Recruitment metric has a high level of reliability with a Cronbach's Alpha 0.83, and AVE 0.736 which when added, shows that it has good internal consistency and acceptable convergent validity. The higher Cronbach's Alpha of 0.89 and AVE of 0.822 show Green Training to have an extremely high degree of reliability, indicating a high internal consistency and a strong convergent validity. The Green Compensation/Reward construct also presents good reliability with a Cronbach's Alpha of 0.84 and an AVE of 0.750. In spite of the fact that Green Empowerment has slightly lower metrics, it still has a reasonable level of reliability, with the Cronbach Alpha of 0.78 and the AVE of 0.670. Both constructs related to Environmental Sustainability and Artificial Intelligence have a high degree of reliability and convergent validity, respectively. The overall Cronbach's Alpha of 0.845 of all the constructs highlights the reliability of the measurement tool. Together, these results prove that the constructs that are used in this study are reliable and valid as well, which supports the soundness of the results obtained in the study.

Table 2. Measurement model.

Construct	Item	Factor Loading	Cronbach Alpha	AVE
Green Recruitment (Gr_Rec)	Gr_Rec1	0.84	0.83	0.736
	Gr_Rec2	0.87		

	Gr_Rec3	0.86		
	Gr_Rec4	0.88		
Green Training (Gr_Tr)	Gr_Tr1	0.89	0.89	0.822
	Gr_Tr 2	0.91		
	Gr_Tr 3	0.90		
Green Compensation/Reward (Gr_C.Re)	Gr_C. Re1	0.85	0.84	0.750
	Gr_C. Re2	0.87		
	Gr_C. Re3	0.88		
Green Empowerment (Gr_Emp)	Gr_Emp1	0.80	0.78	0.670
	Gr_Emp2	0.82		
	Gr_Emp3	0.79		
	Gr_Emp4	0.83		
	Gr_Emp5	0.81		
Environmental Sustainability (Env_Sus)	Env_Sus1	0.86	0.88	0.742
	Env_Sus2	0.85		
	Env_Sus3	0.84		
	Env_Sus4	0.87		
	Env_Sus5	0.83		
	Env_Sus6	0.85		
	Env_Sus7	0.88		
	Env_Sus8	0.84		
	Env_Sus9	0.82		
	Env_Sus10	0.81		
	Env_Sus11	0.83		
	Env_Sus12	0.80		
	Env_Sus13	0.87		
	Env_Sus14	0.86		
	Env_Sus15	0.85		
	Env_Sus16	0.84		
	Env_Sus17	0.86		
Artificial Intelligence (Art_Int)	Art_Int1	0.86	0.85	0.724
	Art_Int2	0.85		
	Art_Int3	0.84		
	Art_Int4	0.83		
	Art_Int5	0.87		
	Art_Int6	0.85		
	Art_Int7	0.82		
	Art_Int8	0.84		
	Art_Int9	0.83		
	Art_Int10	0.86		

2. DISCRIMINANT VALIDITY

The analysis of the HTMT shows that the robust discriminant validity of all constructs under investigation, Green Recruitment, Green Training, Green Compensation/Reward, Green Empowerment, Environmental Sustainability, and Artificial Intelligence, is observed. All the HTMT coefficients are between 0.59 and 0.78, below the standard criterion of 0.85, and therefore, they confirm that every construct is

empirically different and reflects a separate dimension of the model. The highest observed coefficient (0.78) between Green Training and Environmental Sustainability points to a weak but acceptable relationship, which is congruent with the assumption that efficient green training may lead to the improvement of the environmental performance. The value of HTMT of 0.78 between green training and environmental sustainability is relatively high, but it still is within a range of acceptability. This closeness incorporates the theoretically anticipated connection between training interventions and sustainability results, even when they are supporting empirical uniqueness between capability-building processes and performance results. On the other hand, the lowest correlation coefficient (0.59) between the Green Recruitment and the Green Empowerment highlights a strong conceptual distance. All these results support the high discriminant validity of the measurement model and therefore provide confidence to rely on the validity and independent nature of the individual constructs in future structural analysis.

Table 3. Validity statistics.

Constructs	GT	GC/R	GE	ES	AI
Green Recruitment (GR)	0.68	0.63	0.59	0.72	0.66
Green Training (GT)	—	0.70	0.64	0.78	0.74
Green Compensation/Reward (GC/R)		—	0.61	0.75	0.69
Green Empowerment (GE)			—	0.67	0.65
Environmental Sustainability (ES)				—	0.71

3. FORNELL-LARCKER CRITERION

The Fornell–Larcker criterion was employed to assess discriminant validity by comparing the square root of the AVE values (diagonal elements) with inter-construct correlations. The square root of AVE values for all constructs (ranging from 0.82 to 0.91) exceeds their corresponding correlations with other constructs. For instance, Green Training demonstrates its highest correlation with Environmental Sustainability (0.70), which is lower than its square root of AVE (0.91). Similarly, Environmental Sustainability has its strongest association with Green Training (0.70), yet this remains below its diagonal value (0.90). As all diagonal values are greater than the off-diagonal correlations, the Fornell–Larcker criterion is satisfied, confirming adequate discriminant validity among the constructs.

Table 4. Fornell–larcker criterion.

	GR	GT	GC/R	GE	AI	ES
GR	0.86					
GT	0.55	0.91				
GC/R	0.50	0.60	0.87			
GE	0.48	0.53	0.49	0.82		
AI	0.52	0.58	0.54	0.46	0.87	
ES	0.57	0.70	0.63	0.51	0.66	0.90

4. STRUCTURAL MODEL

The structural model demonstrates strong explanatory and predictive power. The R² value of 0.67 indicates that 67% of the variance in Environmental Sustainability is explained by the predictors, reflecting substantial explanatory strength. The Q² value of 0.41 confirms strong predictive relevance. Effect size results show that Green Training has a large impact (f² = 0.32), while Green Compensation/Reward (f² = 0.21) and Green Recruitment (f² = 0.15) exert moderate effects, and Green Empowerment (f² = 0.09) contributes a small but meaningful effect. The model fit indices further support robustness, with significant APC (0.471, p < .001) and ARS (0.67, p < .001) values. The AVIF value of 2.63 indicates no multicollinearity concerns. A large GoF value (0.58) and ideal SPR, RSCR, SSR, and NLBCDR values (all 1.00) confirm that the model is well specified

and free from pathological issues. Overall, the results suggest a statistically sound and well-fitting structural model.

Table 5. Model quality indices.

Index	Value
R ² (Env_Sus)	0.67
Q ²	0.41
f ² (Green Training)	0.32 (Large)
f ² (Green Compensation)	0.21 (Medium)
f ² (Green Recruitment)	0.15 (Medium)
f ² (Green Empowerment)	0.09 (Small)
Average Path Coefficient	0.471 (p < .001)
Average R-squared	0.67 (p < .001)
Average Variance Inflation Factor	2.63 (< 3.3 acceptable)
Goodness of Fit- GoF	0.58 (Large)
Simpson's Paradox Ratio	1.00
Statistical Suppression Ratio	1.00
Nonlinear Bivariate Causality Direction Ratio	1.00

The result of the path analysis, as presented in the following table, indicates that there was a considerably high positive relationship between the discrete green human resources (HR) practices and environmental sustainability. Particularly, there is a positive relationship between green recruitment and improved sustainability with a beta coefficient of 0.302 and p-value of less than 0.001, thus illustrating a positive impact of green recruitment. The most influential of them is green training, as its beta coefficient is 0.620, and the p-value is very significant, less than 0.001, which demonstrates the huge effect that efficient environmental training programs have on sustainability metrics. Also, green compensation and reward systems have a positive impact on environmental sustainability and the beta coefficient of 0.450 and p-value of less than 0.001 indicates the importance of rewarding the green effort in realizing better environmental outcomes. Although the effect of green empowerment is not as significant, it has a positive effect on sustainability, as the beta coefficient corresponding to it is 0.253 and a p-value of less than 0.001, which indicates that enabling the employees to take part in green activities has a positive, but less significant effect. All these findings underscore the need to integrate overall green HR practices to increase environmental sustainability, whereby green training shows the greatest impact, followed by the green compensation/reward, green recruitment, and green empowerment. The results are in line with the past literature [57, 58].

Table 6. Path analysis.

Path Analysis	Beta	P-Value
Green_Recruitment ~ Environmental_Sustainability	0.302	<0.001
Green_Training ~ Environmental_Sustainability	0.620	<0.001
Green_Compensation_Reward ~ Environmental_Sustainability	0.450	<0.001
Green_Empowerment ~ Environmental_Sustainability	0.253	<0.001

5. MODERATION RESULTS

The results of moderation analysis, as shown in the following table, indicate that AI has significant positive impact on the relationship between discrete green human resource (HR) practices and environmental sustainability. Notably, green training has highest beta value (.694) following by green compensation and reward (.587), green recruitment (.439) and green empowerment (.321) respectively.

Table 7. Moderation results.

Moderation Results	Beta	P Value
Gr_Rec × Art_Int → Env_Sus	0.439	<0.001
Gr_Tr × Art_Int → Env_Sus	0.694	<0.001
Gr_C.Re × Art_Int → Env_Sus	0.587	<0.001
Gr_Emp × Art_Int → Env_Sus	0.321	<0.001

In addition, AI show significant impact on the relationship of all the constructs and environmental sustainability as their p value is less than .01. The results state that AI supports green initiatives through green HR practices in the organizations for sustainable future. As a whole, the findings confirm that AI serves as a powerful enabler of green HR practices particularly green training and development domain. Simple slope analysis indicated stronger positive relationships between Green HR practices and Environmental Sustainability at high levels of AI Integration (+1 SD) compared to low levels (-1 SD). The strongest interaction was observed for Green Training ($\beta = 0.694$, $p < .001$), followed by Green Compensation ($\beta = 0.587$), Green Recruitment ($\beta = 0.439$), and Green Empowerment ($\beta = 0.321$)

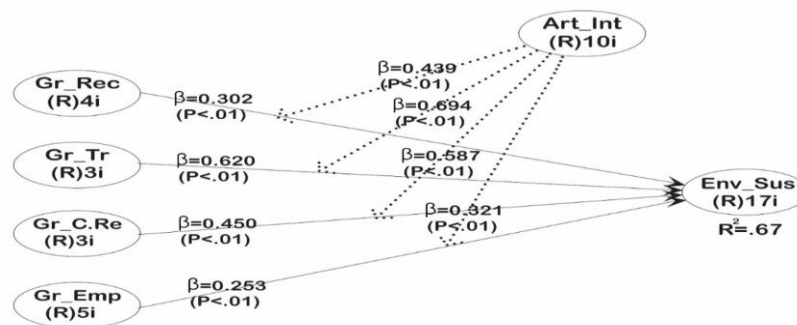


FIGURE 2. SEM analysis.

V. DISCUSSION

The findings of the path analysis and those of the moderation analysis bring out the complex nature of relations among different green HR practices and their impact on environmental sustainability in the organizational context. The path analysis shows that all the elements of green HR, including recruitment, training, compensation, and empowerment, have significant roles in formulating environmental outcomes. The findings of this study are consistent with those of several other studies [59-61]. The results also show the positive relationship between the improved green recruitment policies such as the addition of the green criteria to the hiring procedures and the general environmental sustainability in organizations. Moreover, the analysis has brought out the paramount significance of integrative green training programs because it is observed that the impact of integrative educational interventions targeting environmental practices is the strongest effect on sustainability outcomes. In addition, path analysis indicates that reward systems and compensation structures have a major influence on the motivation of green behaviors and the involvement of employees in green behaviors has an enabling influence, although it is lower than the influence of other practices. As far as moderation analysis is concerned, the moderation tests explain how artificial intelligence (AI) can transform its nature to improve the effectiveness of green HR practices.

The current research supports the findings of the earlier research studies[46,47]. This relatively lesser moderating role of AI on green empowerment can be explained with the fact that the process of empowerment is human-based by its nature. Although AI may offer informational aid and feedback

processes, empowerment depends on trust, autonomy, and organizational culture as it is less prone to technological enhancement as compared to training or reward systems. Hence, the moderating effect of AI in the relationship of green recruitment, training, compensation, and empowerment initiatives on environmental sustainability in organizations becomes a potent phenomenon that is considerably intensified by AI. In this respect, the application of AI technologies will allow improving HR practices significantly and making them more efficient toward environmental sustainability. The moderation analysis shows the different impacts of AI on the different green HR practices, with the greatest impact of the former noted in the green training, then the compensation and reward, recruitment, and empowerment practices. To conclude, the minute analysis of the path and moderation analyses indicates that green practices in HR are complex and very vital in the promotion of the goals of environmental sustainability within organizations. With the emphasis on strong green HR practices supplemented by AI, organizations can successfully promote the culture of environmental sustainability and contribute greatly to the overall sustainability goals.

VI. CONCLUSION

The path analysis findings have clearly shown that the overall green HR practices are fundamental in improving the environmental sustainability within organizations. Most of the elements of green HR, including recruitment, training, compensation, and empowerment make a positive contribution to environmental performance, albeit at varying degrees. The study [1] show similar results. To begin with, the findings indicate that an improved level of environmental sustainability is highly linked to an enhanced green recruitment practice as indicated by beta and p-value are 0.302 and below 0.001 respectively. This conclusion implies that the application of green principles to recruitment procedures can have a positive effect on environmental performance. Out of the green HR practices discussed, the green training seems to be the most influential with a substantial beta coefficient of 0.620 and a significant p-value of minor than 0.001. This brings out the critical nature of rigorous training programs that are aimed at environmental practices in delivering organizational sustainability.

Besides, there is a significant positive relationship between green compensation and reward systems and environmental sustainability with a beta value of 0.450 and p-value of below 0.001. This reiterates the need to encourage and reward employees on their green activities to realize high environmental outcomes. Although green empowerment has a slightly lower impact in comparison to other practices, it has its benefits on the sustainability of the environment as shown by a beta coefficient of 0.253 and a p-value of less than 0.001. This means that allowing the employees to be involved in the green initiatives also enable the organizations to sustain themselves. Additionally, the moderation analysis shows that artificial intelligence (AI) plays a vital role in increasing the efficiency of green HR practices in supporting the environmental sustainability. The work signifies the beneficial influence of AI implementation in many spheres of green HR, such as recruitment, training, compensation, and empowerment. The studies of [53] and [43] show similar results. The results indicate that the concept of using AI in recruitment procedures significantly improves the quality of green recruitment activities as shown by a strong beta coefficient of 0.439 and a very significant p-value of less than 0.001. Similarly, the effect of the environmental practices training programs is significantly increased by AI with a beta of 0.694 with a p-value of less than 0.001.

In addition, the investigation has found out that AI has a positive impact on green compensation and reward systems with a beta coefficient of 0.587 with a p-value of less than 0.001 indicating its significance in enhancing the effectiveness of reward systems in ensuring environmental sustainability. AI also enhances the performance of green empowerment initiatives albeit with a smaller margin as indicated by a beta coefficient of 0.321 and a p-value of less than 0.001. All in all, these results highlight the importance of artificial intelligence in enhancing the performance of green HR practices to promote environmental sustainability in the organizational setting. The paper shows that AI plays a very important role in the moderation of the effect of several green HR practices where green training has the highest moderating power, then green compensation and reward, green recruitment and then green empowerment. The use of

AI technologies to support these practices allows organizations to better tackle the environmental issue and build a more sustainable future. The adoption of extensive green HR practices, especially those which focus on green training have to be put at the forefront in ensuring environmental sustainability in the organizations.

1. THEORETICAL IMPLICATIONS

The given research makes an important contribution to the theoretical comprehension in the field of green human resource management, the integration of artificial intelligence, and organizational sustainability. Firstly, the empirical evidence of the moderating effect of AI on the relationship between GHRM practices and environmental sustainability supplements the Ability, Motivation, Opportunity (AMO) model. Moreover, the study explains the ways in which AI can help employees develop new abilities by use of data-based training. Growing the opportunities by introducing digital empowerment platforms makes sustainable behavior possible. The remodeling of the AMO model creates digital intelligence at the center of the modern renaissance of sustainability-oriented human-resource performance, thus providing a new theoretical lens that combines technological innovation and environmental psychology.

The paper also sheds light on the Resource-Based View (RBV) and the Dynamic Capabilities Theory (DCT) by reconsidering the concept of artificial intelligence (AI) as a strategic resource that enables the formation of dynamic capabilities within the environmental setting. Based on empirical data, organizations that introduce AI not only accomplish operational efficiency but also gain adaptive capabilities that make it possible to align the human-resource strategies with ecological goals. Such an observation is supported by the existing theories that suggest that AI-based analytics and automation make organizations more responsive to environmental needs. Besides, the article strengthens the Sustainable HRM theory by describing AI as a moderating tool that will reshape the conventional HR roles into strategic facilitators of green performance, thus, attaining an empirical validation of how the inclusion of AI into HRM systems enhances the effect of the ecologically responsible training and reward practices, which serve as the primary hammers in building an ecologically responsible organizational culture. Besides, the paper adds some valuable knowledge to the infant literature in the field of digital transformation and sustainability. It proves that AI-based human-resource management (HRM) does not only streamline the internal processes, but also allows building the global sustainability models, like the United Nations Sustainable Development Goals (SDG 8: Decent Work and Economic Growth, SDG 13: Climate Action). As a result, the piece serves as a conceptual framework that reinvents AI as a means of operation as a supplementary activator in the greater sustainability discourse.

2. PRACTICAL IMPLICATIONS

The study provides useful information to organizational managers, human-resource practitioners, and policymakers trying to incorporate AI and sustainability in strategic HRM systems. The results show that the green training that is enhanced with AI produces the most significant impact on environmental sustainability. The findings suggest that organizations should focus on AI-based e-learning, simulation-based sustainability training and adaptable training algorithms to customize the learning experiences to individual employee requirements. HR managers are able to use AI analytics to track behavioral variations, measure carbon-reduction effects, and refine training interventions through trial and error.

Equally, the positive moderating power of AI on the green compensation and reward systems highlights the possibility of digital tools to develop open and data-informed reward systems. AI-based performance tracking systems can help organizations acknowledge sustainable behaviors of employees in real time and tie its rewards to quantifiable environmental performance like waste minimization or energy savings. The recruitment platforms that use AI can be used to simplify green hiring through natural language processing and predictive analytics to offer the most sustainable-related candidates that have the right values that will enhance the ecological fit of the workforce. Within the context of employee empowerment, AI tools, such as sustainability dashboards, mobile apps and feedback systems, allow employees to track how they contribute to the environment and participate in new green projects. The study highlights to the policymakers the

urgency to develop regulatory laws and ethical principles to be used in the application of AI in HRM to maintain transparency, fairness and environmental responsibility. Digital sustainability infrastructure and AI literacy programs will be necessary in order to empower organizations, especially those in the developing economy, to make responsible adoption of sustainable technologies. Finally, showing the compatibility of AI and green HRM, the study helps organizations to redefine the concept of performance management ecologically, transforming HRM into administrative effectiveness into the ecological responsibility of the planet.

3. LIMITATIONS & FUTURE RESEARCH DIRECTIONS

The limitations of this study can be categorized into methodological and conceptual domains. Methodologically, the cross-sectional design, reliance on self-reported data, and country-specific sample restrict causal inference and generalizability. Conceptually, the study treats artificial intelligence as a unified construct, without differentiating between specific AI technologies or maturity levels, which future research may explore in greater depth. This quantitative study investigates how artificial intelligence (AI) moderates the relationship between green HR practices and environmental sustainability within Pakistani organizations. However, the study is limited in a number of ways. The specialism brought about by the particular attention to Pakistan could limit the possibility of generalizing the results to other geographical areas with different cultural and economic backgrounds, whose technological adoption and environmental regulation trends are significantly different. Though the sample size is statistically sufficient, it might not be able to capture a heterogeneous enough sample of different industry sectors, different sizes of organizations and groups of employees can question the generalizability of the study. The fact that the study is cross-sectional in nature and gathered data at one moment in time limits the ability to draw cause and effect conclusions or to track the longitudinal developments. In addition, the use of self-reported data exposes it to a vulnerability of response bias because the respondent might exaggerate positive behaviors or attitudes towards sustainability and artificial intelligence due to social desirability or fear of adverse consequences. The research also ignores the systematic differences in artificial-intelligence technologies and their implementation channels, which might have a fallout effect on the efficacy of AI to support green human-resources practices. Although the study describes the ethical issues like the privacy of data, bias in the algorithms and transparency, these aspects are not discussed in detail, which may affect the acceptance of AI-based green HR programs and their effectiveness.

The research in the future ought to attempt to overcome these limitations by using comparative research studies in different countries and regions to clarify the effects of cultural, regulatory, and economic factors in determining the adoption of artificial intelligence in green human-resource practices, thus increasing the generalizability of the results. Additional research on the impact of new AI-based technologies such as machine learning and blockchain on green HR will offer a vision of the AI implementation. Overcoming ethical issues like privacy of data, bias in the algorithm, and transparency requires the creation of strong ethical considerations that can make AI-related HR practices highly effective and ethically sound. Furthermore, the study needs to investigate perception and beliefs of the employees towards AI-mediated green HR processes; the insights into the predictive elements of employee attitudes will enable the development of AI systems, which will not be perceived as intimidating and will be accepted by the majority. Future studies can also produce more accurate indicators that would quantify the environmental performance of AI-enhanced green HR practices and standardize measures to determine the contribution of the particular AI-based solution to the reduction of carbon footprints and the achievement of sustainability. Reduction of research constraints and future directions will help shed some light on the dynamics between artificial intelligence, green human-resource practices and environmental sustainability which will eventually result in more effective and sustainable organizational performance.

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Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Upon request, data can be obtained from the authors.

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