Relationship between green human resource management practices & environmental sustainability by green innovation

MUHAMMAD WAQAS NAZIR
SHEN ZUNHUAN

LIAQUAT ALI RAHOO

ABSTRACT – REZUMAT

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Protecting natural resources for future generations has become an important concern in the debates among policymakers and institutions. Sindh is the third largest province by geography and the second most urbanised province, located in the southeast of Pakistan. This study aims to empirically analyse the role of green human resource management practices on environmental sustainability in higher educational institutions in Sindh, Pakistan, particularly those offering degrees and responsible for research in textile engineering and fashion design. Further, we explore whether green innovation as a potential mediator stimulates the relationship between green human resource management and environmental sustainability. We employed a quantitative research technique and retrieved data from 376 respondents who are employees of higher education institutions. This study for analysis used SPSS 26 and partial least squares based on structural equation modelling (SEM). Our outcomes suggested that green human resource management promotes environmental sustainability. Notably, green recruitment and selection (0.384) exerts the strongest influence on environmental sustainability, followed by green training and development (0.341), green compensation and reward (0.232) lastly green performance management (0.184) also contribute positively to environmental sustainability. All relationships observed in the study were statistically significant (p<0.05). The current study finds that green innovation partially mediates the relationships between all constructs and plays a crucial role in enhancing environmental sustainability. This study provides insightful recommendations for educational institutions currently operating in Pakistan and other emerging economies to achieve sustainability objectives. It also promotes eco-friendly practices and raises awareness among stakeholders, contributing to the achievement of environmental sustainability.

Keywords: environmental sustainability, green HRM, green innovation, textile and fashion design, higher educational institutions, Pakistan

Relația dintre practicile ecologice de gestionare a resurselor umane și sustenabilitatea mediului prin inovare ecologică

Protejarea resurselor naturale pentru generațiile viitoare a devenit o preocupare importantă în dezbaterile dintre factorii de decizie și instituții. Sindh este a treia provincie ca mărime din punct de vedere geografic și a doua provincie ca grad de urbanizare, situată în sud-estul Pakistanului. Acest studiu își propune să analizeze empiric rolul practicilor de gestionare ecologică a resurselor umane asupra durabilității mediului în instituțiile de învățământ superior din Sindh, Pakistan, în special cele care oferă diplome și sunt responsabile de cercetarea în domeniul ingineriei textile și al designului de modă. În plus, explorăm dacă inovarea ecologică, ca potențial mediator, stimulează relația dintre managementul ecologic al resurselor umane și sustenabilitatea mediului. Am utilizat o tehnică de cercetare cantitativă și am colectat date de la 376 de respondenți, care sunt angajați ai instituțiilor de învățământ superior. Acest studiu a utilizat pentru analiză SPSS 26 și metode parțiale ale celor mai mici pătrate bazate pe modelarea ecuațiilor structurale (SEM). Rezultatele noastre sugerează că managementul ecologic al resurselor umane promovează sustenabilitatea mediului. În mod deosebit, recrutarea și selecția ecologică (0,384) exercită cea mai puternică influență asupra sustenabilității mediului, urmată de formarea și dezvoltarea ecologică (0,341), compensarea și recompensarea ecologică (0,232) și, în cele din urmă, managementul performanței ecologice (0,184), care contribuie, de asemenea, în mod pozitiv la sustenabilitatea mediului. Toate relațiile observate în studiu au fost semnificative din punct de vedere statistic (p<0,05). Studiul actual constată că inovarea ecologică mediază parțial relațiile dintre toate constructele și joacă un rol crucial în îmbunătățirea durabilității mediului. Acest studiu oferă recomandări pertinente pentru instituțiile de învățământ care funcționează în prezent în Pakistan și în alte economii emergente, în ceea ce privește obiectivele de sustenabilitate. De asemenea, promovează practici ecologice și crește gradul de conștientizare în rândul părților interesate, contribuind la sustenabilitatea mediului.

Cuvinte-cheie: sustenabilitate ecologică, gestionarea ecologică a resurselor umane, inovare ecologică, design textil și de modă, instituții de învățământ superior, Pakistan

INTRODUCTION

Since industrialisation has significantly advanced societal development, it has also been associated with serious challenges, such as environmental degradation. Consequently, these issues necessitate the adoption of sustainable practices. Moreover, modernisation has also increased environmental awareness, and active campaigns regarding sustainability driven by civil societies have further compelled organisations to embrace eco-friendly initiatives [1]. However, a concrete effort is required from civil society stakeholders to achieve environmental sustainability. Higher educational institutions are one of the main actors in the services industry, having a critical role in shaping the future. Their primary responsibility is to provide knowledge-based services and innovations to society. Moreover, these are also the main source of skilled human resources for organisations. Besides this, higher education institutions are equally responsible for sustaining the environment.

Therefore, as their third mission, HEIs are also responsible for upgrading society to support the ecology. Beyond their traditional functions, it is essential for HEIs to integrate initiatives and policies into their operations and practices that promote sustainability [2]. The concept of Green Human Resource Management (GHRM) has emerged as one of the transformative practices for embedding environmental. It incorporates strategies within traditional work processes to address environmental challenges, and its significant environmental benefits have drawn increasing attention today.

Therefore, advanced governance models are implementing these practices. At the same time, organisations are also considering adopting GHRM as a possible change agent [3, 4]. Various GHRM practices have significant potential to enhance organisational commitment to environmental wellbeing. Therefore, researchers are interested in a more keen understanding of the relationship between environmental sustainability and GHRM practices by highlighting the need for this tool to be utilised in organisations [5, 6]. Green innovation (GI) refers to adopting eco-friendly products and processes to reduce environmental harm. This emerging concept is particularly relevant in all sectors, including the services sector, such as higher education, where integrating green practices can significantly lower the environmental footprints. Pakistan, being the fifth most populous country globally, has a rich history of textile production, with evidence of cotton cultivation and fabric manufacturing dating back to ancient times. This heritage is evolving into a diverse textile industry and impacting worldwide through its traditional craftsmanship. Currently, the country operates various operational textile units, whereas Sindh is particularly the home of the textile industry because of its several industrial zones. There are 09 working locations for Cotton processing, 04 leather industries, 04 wool processing industries, 05 manufacturing silk and rayon, and 04 for jute production, as well as many small and medium enterprises (SMEs) related to fashion design are empowering themselves in this region. These industries gain a direct supply of human resources from regional higher education institutions offering related degrees (HEIs) [7]. These institutions in Sindh are established to produce skilled human resources related to textile and fashion design education to meet local and global economic demands. Despite their significant economic and cultural contributions, HEIs in Sindh province are facing urgent challenges, particularly related to environmental degradation.

Furthermore, there is a limited understanding of how GHRM and GI influence sustainability within HEIs in Sindh. It highlights a critical gap, as environmental challenges threaten the long-term sustainability of different sectors in Pakistan. Previously, much of the literature emphasised the influence of GHRM and GI on environmental sustainability, but their application in HEIs, especially within developing countries like Pakistan, has remained underexplored. Given this background, the current study seeks to bridge this identified gap by investigating the relationship between GHRM practices and environmental sustainability in Sindh province HEIs. Secondly, this study intended to contribute to the literature by extending the role of GI as a mediating factor. Drawing on the Resource-Based Theory (RBT), which emphasises the strategic value of internal organisational resources. This research examines how HEIs can leverage GHRM to achieve their sustainability goals. Furthermore, this integration of GHRM practices and GI is expected to offer actionable insights into how HEIs can address environmental issues and strengthen their practices according to the global sustainability standards. This research is novel and contextually relevant by offering theoretical contributions to the literature. Furthermore, it provides practical recommendations to institutional leaders to align their operations with sustainability trends. By focusing on the intersection of GHRM, GI, and environmental sustainability, this study underscores the importance of embedding GHRM practices within the operational frameworks of HEIs. Insights of this study will benefit HEIs in Sindh province and serve as a reference for the institutions of other regions of Pakistan, neighbouring countries, and other nations that are grappling with environmental challenges.

The study is divided into five main sections. The first section introduces the overall study. The second section presents a review of relevant literature, the development of hypotheses and the research framework. The third section details the research methodology and data collection process. The fourth section analyses the findings based on empirical data. Finally, the fifth section concludes the study, discusses implications for future research, provides recommendations, and the last chapter is followed by a reference.

REVIEW OF LITERATURE AND HYPOTHESIS DEVELOPMENT

Green human resources and environmental sustainability

Nowadays, traditional Human Resource Management (HRM) practices are shifting to modern approaches [8]. This change has initiated the development of strategies that incorporate environmental objectives to achieve dual goals such as organisational competitiveness and sustainability. The concept of Green Human Resource Management (GHRM) has previously been examined from various perspectives. For example, Renwick et al. characterised GHRM as a subset of HRM that focuses on environmental impact [9]. At the same time, Opatha and Arulrajah see it as a mechanism to cultivate environmentally conscious employees who can contribute to environmental objectives [10]. Similarly, Masri and Jaaron highlighted the GHRM role in encouraging eco-friendly behaviours among employees [11]. These practices also support organisational efforts to achieve the environmental goals [12]. Previously, researchers have underscored enough evidence through different studies that GHRM practices are essential for sustaining the organisational environment [13]. However, it was observed that developing countries are less studied in terms of practising these practices, and the authors emphasised exploring these areas further to enhance environmental sustainability [6]. Previously, we have seen much empirical evidence that suggests a significant relationship between GHRM and environmental sustainability. For instance, in the context of the Malaysian manufacturing sector, Hossain documented the positive connection between GHRM and Environmental Performance (EP) [14]. By exploring another setting of the hospitality industry, it was argued that GHRM practices significantly mediate the relationship between proactive pro-environmental behaviour (PEB) and green inclusive leadership (GIL), which improves sustainability [15, 16]. Prior studies have acknowledged that GHRM practices are essential for Environmental Sustainability (ES). However, the literature has insufficient evidence to confirm the relationship between GHRM and ES and green Innovation (GI) in the context of higher education institutions, mainly located in an underdeveloped region. This relationship has been unexplored empirically until now. Therefore, based on the recommendation of Pham et al. [6], this study intended to empirically fill this gap. The current study will examine the 04 dimensions to explore the impact of GHRM on ES.

Green compensations and rewards

Institutions attract employees through compensation to sustain eco-friendly practices. These incentives range from monetary or verbal appreciation to additional skill enhancement training. These strategies can be a win-win for both employers and employees. These compensations help in improving work-life balance, promoting eco-friendly behaviours, and also instil a sense of future confidence in the participants.

This can reshape the approach toward sustainability [16, 17]. Previously, empirical evidence acknowledged that green compensation improves sustainability. For instance, a study conducted by Das in the context of ISO 14004 manufacturing organisations, the author articulated that green compensations are essential for environmentally aware organisations to fulfil their sustainability goals. The study also highlighted the long-term benefits of green compensation to improve sustainability [18]. In another study, the author suggested that compensation can significantly influence Organisational Citizenship Behaviour for the Environment (OCBE). It was also noted that employees with less than five years of service are more attracted to these compensations, which encourage them to engage in pro-environmental behaviours. This study further emphasised the need to explore GHRM practices with other variables to achieve environmental sustainability [19]. Similarly, a study of the healthcare sector posits that organisations can boost their sustainability efforts by providing green compensation by inspiring employees to be more aware of and engage with environmental challenges. This approach plays a key role in conserving natural resources and safeguarding ecosystems, which leads to long-term environmental sustainability [20]. In another study, Amjad surveyed the textile sector of Pakistan and affirms that green compensation is significantly associated with employee performance and organisational sustainability [21]. Based on these findings, we propose the hypothesis (H1): Green compensation and reward positively impact environmental sustainability.

Green performance assessment and appraisal

Performance assessment is a process that regularly evaluates an employee's performance to sustain organisational objectives. In contrast, assessing employee environmental activities within an organisation's environmental management is called Green Performance Management. It is very crucial to integrate environmental objectives into organisational frameworks. Performance assessment strategies ensure the enhancement of environmental outcomes in the organisation by fostering employees toward green practices. Scholars believe that assessing employees' contributions towards environmental goals can drive pro-environmental attitudes.

Furthermore, it aligns individual actions with organisational sustainability objectives to lead to environmental sustainability [6, 22, 23]. Many researchers, such as Arulrajah and Kuo, have acknowledged the importance of green performance appraisals. Furthermore, the authors articulated that managers are responsible for supervising employees and assessing their contributions toward eco-friendly practices to promote continuous environmental improvements in the organisation [10, 24].

Nowadays, organisations can evaluate employee performance more easily by incorporating technology that streamlines the process, facilitates assessment and enhances the environmental outcomes [25].

However, improper policy implementation, limited resources, or lack of awareness can impact the effectiveness of these systems. Organisations should establish common standards for implementing green performance assessments to address these challenges and clearly define their indicators. This includes incorporating new criteria into performance evaluations to assess workers' technical and behavioural competencies, such as environmental stewardship, innovation, diversity, and collaboration. These competencies strengthen the organisational core principles and align employee efforts with sustainability goals [26]. The literature suggests that effectively implemented green performance assessments significantly contribute to achieving environmental sustainability. Thus, we hypothesise that (H2): green performance assessment positively impacts environmental sustainability.

Green recruitment and selection

Green recruitment integrates environmental sustainability standards into the hiring processes by focusing on recruiting pro-environmental candidates. It also involves designing job descriptions that emphasise environmental responsibilities [27]. This approach ensures its genuine importance at the entry point of the HRM system and underscores the organisation's enthusiasm for environmental sustainability by recruiting environmentally conscious employees. It helps to reduce resources during the hiring process and ensures that employees are effectively aligned with the organisation's pro-environment attitude. This will lead to a long-term impact on environmental sustainability [28]. According to past research, green recruitment has a long-term impact on organisational sustainability. Pham and Khattak highlighted in this context that organisations implementing green hiring strategies are more likely to attract environmentally aware candidates and build a workforce that is actively involved in sustainability efforts [5, 29]. Latha indicated that by utilising digital platforms such as digital applications and interviews, organisations can reduce the environmental footprint of recruitment processes [30]. Another study was conducted during the post-pandemic period, and the data were collected from Pakistan's telecom industry. The author documented the positive impact of GRS on the decrease of the environmental footprint during the pandemic [31]. Kuo et al. articulated that green recruitment enhances the organisation's overall environmental performance by creating a workforce attuned to ecological preservation [24]. Lastly, wang found that organisations experience practical benefits by adopting GRS. The author recognised green recruitment and selection (GRS) as an important practice that directly helps organisations to obtain green human capital. In addition, this study also emphasised that through GRS, organisations can recognise the positive attributes of employees, which contribute in the form of environmental sustainability [32]. Based on the above-mentioned literature support. We have supported this hypothesis: H3 Green recruitment and selection positively impact environmental sustainability.

Green training and development

Training is a critical tool to elevate the employees' competencies and enables them to be more committed to organisational tasks [33]. As a driving force for environmental sustainability, GHRM integrates green training into the HRM process to equip employees with in-depth knowledge and expertise to make decisions that contribute to saving the environment [9]. These trainings are considered the central aspect of green human resource management. Because it is involved in the development of educational programs and raising awareness among employees to incorporate the environmental sustainability goals in the organisational objectives [34]. These trainings foster energy conservation, resource efficiency, and employee productivity. It not only encourages organisations to pursue environmental preservation but also inspires their stakeholders to adopt sustainable green practices [35]. Previously, these trainings have been explored in various dimensions. Literature suggests that organisations can gain multiple edges, such as environmental, social, and economic performance, by implementing serious and well-designed training. Bukhari, in this regard, documented that green training supports the organisation's long-term success by enhancing employee workplace safety and is responsible for reducing production expenses, leading to better environmental outcomes [36]. Similarly, studies reported the impact of green training on workers' organisational citizenship behaviour toward the environment (OCBE). The results consistently indicate that green training is responsible for fostering pro-environmental behaviour among the employees, which significantly improves the organisation's environmental performance. Furthermore, green training provides meaningful awareness regarding environmental concerns and rectifies employees' behaviour toward an eco-friendly attitude that leads to a sustainable environment [37]. In the past, several studies have been associated with the examination of green training in different contexts, i.e., hospitality, information technology and pharmaceutical industries. And demonstrated a significant relationship with Environmental sustainability [38, 39]. However, higher educational institutions are the critical pillars for achieving sustainability. This sector is still unexplored as yet. Therefore, extending the previous literature, the current study expects a direct link between green training and environmental sustainability in the context of higher educational institutions. Hence, we have proposed this hypothesis: H4: Green Training significantly affects environmental sustainability.

Mediating role of green innovation

Innovation is a novel idea that is practically applicable, and incorporating the term 'green' ties it to environmental benefits. Literature has viewed green inno-

vation as one of the most promising approaches to addressing environmental challenges [40].

The Organisation for Economic Co-operation and Development (OECD) defined Green Innovations (GI) as "the creation of goods and services, procedures, marketing strategies, organisational structures, and new or enhanced institutional arrangements that, whether on purpose or not, lessen their environmental effect when compared to alternative approaches". Literature divides green innovation into two components: green product and green process innovation. GI has the potential to enhance environmental sustainability by incorporating value addition in systems or processes [41]. Various organisations and countries have already incorporated GI into their processes to compete with their competitors and to address the challenges of environmental degradation [42]. Previously, numerous studies have explored the GI, for instance. The study conducted by Singh focused on the manufacturing firms to evaluate green performance (GP), found that GI builds a connection between GP and Green Transformational Leadership [43]. Correia further conducted a study in the health sector of Pakistan and concluded that green innovation (GI) strengthens the link between green human resource management (GHRM) and sustainable performance. This study further highlighted that organisations that adopt green innovation practices can ensure the protection of the environment in the long run [44].

In parallel with other variables, Green Innovation (GI) has also been identified as a potential mediator between Green Human Resource Management (GHRM) and Environmental Performance (EP). In this regard, Kuo and Fang have seen the positive mediation role of GI between GHRM practices and environmental performance. Authors also articulated that organisations with strong GHRM initiatives can encourage employees to innovate in sustainable practices, a continuous process to enhance environmental sustainability [24, 41–45]. Moreover, another study documented that GI has a significant mediating potential to establish a link between GHRM and EP

[46]. Thus, GI has been previously proven as a potential mediator between different scenarios and contexts. However, the interaction of GI and GHRM practices based on RBV theory remains untested in the context of higher educational institutions. Therefore, we have proposed the following hypothesis: Green Innovation mediates the relationship between GHRM practices and Environmental Sustainability.

RESEARCH METHODOLOGY

The current study was conducted at 13 higher education institutions in Sindh Province, which play an important role in providing human resources, education, and research for the Textile and Fashion Design sector in Sindh Province of Pakistan. We targeted 08 institutions of textile education, offering many programs such as Textile, Dyeing and Printing, Textile Marketing, Fashion Design Management, Appearance Merchandising, and Ceramic Design. Additionally, 05 public sector engineering universities were selected that offer a graduate degree in textile engineering. Geographically, these institutions were distributed as follows: 08 institutions were located in District Karachi, 03 in Jamshoro, 01 in Nawabshah, and 01 in Rohri city. Before the data collection, we obtained approval from the ethical committee, and to maximise the response rate, weekly email reminders were sent to non-respondents for four weeks. We also contacted institutional managers to reinforce these reminders internally to ensure an adequate sample size. We targeted the employees of selected institutions related to the textile sector, with a total population size of 6,568. We explored official websites and institutions' annual reports to identify the population size. Lastly, we approached university resource persons to gather the number of employees. After collecting the population size, we categorised the employees into 05 categories: Upper Management, Middle Management, Lower Management, Academic and Administrative Staff. Then, we employed a Stratified Simple Random
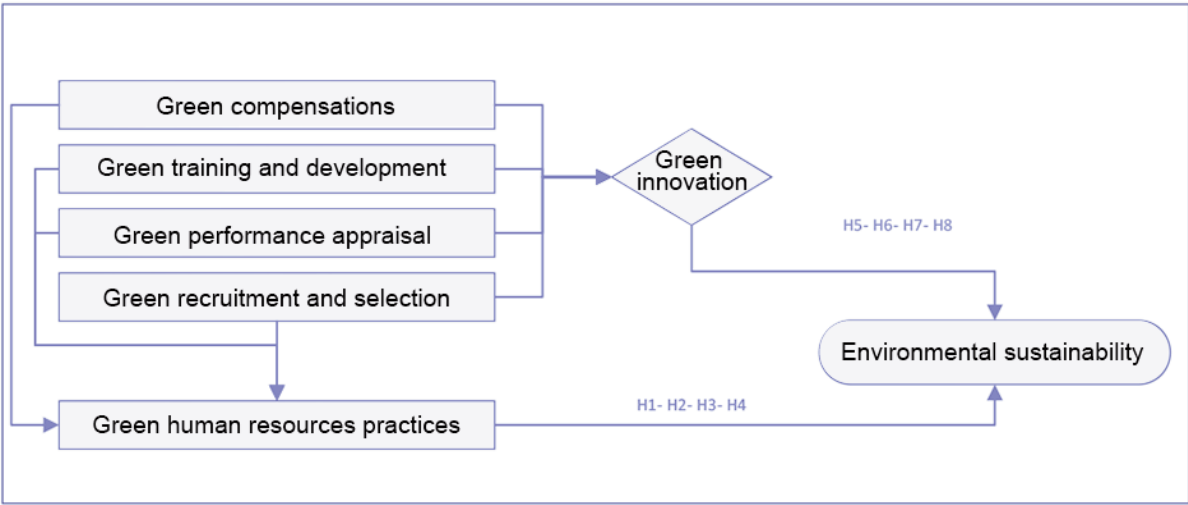

Fig. 1. Conceptual model

Sampling technique to ensure an adequately representative sample. The data collection relied on a structured questionnaire. We initially distributed the questionnaires through Google Forms and emails. The survey instrument included details about the study's purpose, data confidentiality, respondent anonymity, and informed consent; we also sent an encouragement letter to participants to respond truthfully. In the second phase, the physical copies were distributed to respondents in institutions located in Jamshoro District; our research team personally handed out the physical questionnaires at each institution, and to ensure consistency, a standardised procedure was followed: each questionnaire included a cover letter explaining the study's purpose, assurances of confidentiality and instructions for returning the completed form. Initially, we drafted the instrument in English. However, since most people primarily speak Urdu (native language), it was translated into Urdu by a bilingual academic expert, then retranslated back into English by another translator to ensure accuracy and to improve the questionnaire's validity and reliability. After this translation, certain items were refined based on insights gained from the Urdu version of the survey. After refinement, we conducted the pilot survey, and the questionnaire was sent to 24 respondents within the Jamshoro Education city in 02 higher educational institutions to evaluate the effectiveness and clarity of the questionnaire; upon feedback from the respondents, some rectifications were incorporated into the questionnaire, and the primary survey was conducted. A total of 460 questionnaires were distributed among the respondents, and 388 were returned, yielding a response rate of 84.35%. Incomplete responses with missing data were excluded from the analysis to ensure data integrity and consistency; later on, 376 were utilised in hypothesis testing [47]. The data was collected between August 2024 and October 2024. We included five key constructs in the study, which were adopted from previously tested frameworks. Four items of Green Training and Development (GTD) and five indicators of Green Compensation and Reward (GCR) were derived from Daily et al. and Jabbour [3, 48, 49]. Green Performance Assessment (GPA) had 05 items evaluated based on the framework suggested by Masri and Jaaron [11]. Five questions regarding Green Recruitment and Selection (GRS) were examined using criteria from Pham et al. [5]. Lastly, we adopted 03 items from the study of Chen et al. [50] to evaluate the mediating influence of Green Innovation (GI). All current study constructs were measured using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) to ensure consistency and comparability across variables. SPSS version 26 was utilised to analyse respondents' demographic information, then the measurement and structural model analysis utilising the Partial Least Squares (PLS) Structural Equation Model with Smart PLS-4. Additionally, the internal consistency of the scales was assessed using Cronbach's Alpha and Composite Reliability (CR) scores. Model fit was evaluated using R^2 and Q^2 values, which provided insights into the model's explanatory power and predictive relevance.

RESULTS

Demographic distribution

Table 1 illustrates the demographics of the respondents and offers a comprehensive overview of the study's participants. 376 employees have participated

Table 1

PARTICIPANT SPECIFICATIONS (n = 376)			
Demographics	**Description**	**Respondents (n)**	**Percentage (%)**
Biological Sex	Male	249	66.4
	Female	127	33.6
	Total	376	100.0
Marital Status	Married	313	83.5
	Not married	63	16.5
	Total	376	100.00
Occupational position	Lower management	75	19.948
	Middle Management	57	15.152
	Upper Management	59	15.705
	Academia	91	24.211
	Supporting Staff	95	25.266
	Total	376	100
Level of education	Bachelor (16 years)	215	57.2
	Master (18 years)	111	29.5
	Ph.D.	43	11.4
	Post Doc	07	1.9
	Total	376	100

Table 1 (continuation)

Demographics	Description	Respondents (n)	Percentage (%)
Experience	Less than 5 years	75	19.95
	6 to 10 years	113	30.05
	11 to 15 years	95	25.27
	16 to 20 years	58	15.43
	More than 20 years	35	9.30
Total		376	100

Source: Author's self-conducted survey, August 2024 – October 2024.

in the research and represent a diverse background. Regarding gender distribution, 66.4% (n=249) of the respondents were male, whereas 33.6% (n=127) were female. In terms of the marital status of respondents, 83.24% (n=313) reported being married; this indicates a significant proportion of the respondents with familial responsibilities. On the other hand, 16.76% (n=63) were unmarried. Furthermore, the designation distribution allowed us to know that 19.95% (n=75) of respondents were from lower management, such as office superintendents and assistants, 15.15% (n=57) from middle management, such as Assistant managers, 15.71% (n=59) from the upper management, Registrar, Controller of Examinations, Planning Officer and Managers of Quality Enhancement Cell. The academic staff represented 24.21% (n=91) of the total respondents in various positions such as lecturers, assistant professors, associate professors, and professors. These individuals were engaged in teaching and research within the institutions, and their diverse expertise and professional backgrounds provided valuable insights into the academic landscape of textile and fashion design education in the region. While the supporting staff comprised 25.27% (n=95) of participants, these included office assistants, laboratory attendants, and clerks. With respect to educational qualifications, 57.2% (n=215) of respondents held a bachelor's degree (16 years of education) and primarily worked

in the supporting staff or lower management, 29.52% (n=111) had a master's degree (18 years of schooling), 11.44% (n=43) were Ph.D. holders and mostly was from the academia, and 03 was from the middle management. 1.86% (n=7) had a postdoctoral degree and worked in academia. Finally, the respondents' work experience spanned various ranges as follows: 19.95% (n=75) had less than five years of experience, 30.05% (n=113) had six to ten years of experience, 25.27% (n=95) had eleven to fifteen years of experience, 15.43% (n=58) had sixteen to twenty years of experience, and 9.30% (n=35) had more than twenty years of experience. These demographic insights demonstrate the respondents' diversity and ensure a well-represented sample for hypothesis testing and to achieve the study's objectives.

Justification of using the Measurement Model: this model allowed us to study and quantify these constructs through observable indicators and thoroughly analyse their relationships.

Measurement model

The internal consistency of the constructs, described in table 2, was evaluated using Cronbach's alpha, which exceeded the recommended threshold of 0.70, as outlined by Hair Jr. et al. [51]. Additionally, the composite reliability values surpassed the threshold of 0.7, ranging from 0.79 to 0.920, as Hair Jr. et al. indicated. According to Zain [52], the rule of thumb for

Table 2

VALIDITY AND RELIABILITY OF THE CONSTRUCT						
Construct	**Item**	**Outer loading**	**α (≥0.70)**	**CR (≥0.70)**	**AVE (≥0.50)**	**ViF**
Environmental sustainability	ES1	0.793	0.92	0.91	0.64	2.422
	ES2	0.820				2.657
	ES3	0.850				2.721
	ES4	0.787				2.285
	ES5	0.790				2.202
	ES6	0.792				2.726
	ES7	0.775				2.555
Green compensation and reward	GCR1	0.797	0.87	0.87	0.63	2.458
	GCR2	0.799				2.285
	GCR3	0.806				2.202
	GCR4	0.780				2.726
	GCR5	0.801				2.555

Table 2 (continuation)

Construct	Item	Outer loading	α (≥0.70)	CR (≥0.70)	AVE (≥0.50)	ViF
Green innovation	GI1	0.791	0.79	0.78	0.71	1.392
	GI2	0.867				2.124
	GI3	0.855				1.984
Green performance assessment	GPA1	0.867	0.91	0.90	0.76	3.027
	GPA2	0.894				2.124
	GPA3	0.839				1.984
	GPA4	0.898				3.362
	GPA5	0.855				2.604
Green recruitment and selection	GRS1	0.841	0.91	0.91	0.73	2.652
	GRS2	0.856				2.705
	GRS3	0.894				3.541
	GRS4	0.817				2.528
	GRS5	0.849				2.713
Green training and development	GTD1	0.868	0.90	0.79	0.78	2.561
	GTD2	0.885				2.667
	GTD3	0.890				2.844
	GTD4	0.858				2.134

Note: α: Cronbach's alpha; CR: Composite Reliability; AVE: Average Variance Extracted; ViF: Variance Inflation Factor.

Average Variance Extracted (AVE) suggests that values should not be below 0.5. Similarly, table 2 also illustrates that all AVE values for the constructs of the study were more significant than 0.5, indicating the statistical accuracy of the study. The assessment of measurements supported the conclusions drawn by Ying et al. and Korankye et al. [53, 54].

Discriminant validity

Tables 3 and 4 illustrate the variables' discriminant validity to evaluate the distinct measures from the other factors. We followed Henseler et al. [55] and adopted the Fornell and Larcker (1981) criteria. According to Fornell and Larcker (1981), diagonal values should exceed their corresponding correlation coefficient, represented as the square root of the Average Variance Extracted (AVE) values in the diagonal, while Henseler et al. argue that the HTMT ratio of correlations is more reliable than the Fornell-Larcker Criterion we assessed our variables with both HTMT and Fornell-Larcker's measures the discriminant validity of the constructs in the study was satisfactory HTMT values was below the threshold of 0.90, while Based on the Fornell-Larcker criterion in our study all variables shows the satisfactory discriminant validity except one pair of GCR and GPA with high correlation 0.841 then AVE 0.794 and the HTMT threshold was with value of 0.940 exceeded the threshold.

Structural model assessment

The proposed structural model will highlight the interdependence of relationships between green human resource practices and environmental sustainability. Meanwhile, this study will allow us to examine the mediation level of green innovation similarly; the Partial Least Squares (PLS) structural model finally analyses the relationship between regression coefficients and t-values in hypothesis testing.

Table 3

DISCRIMINANT VALIDITY (HETEROTRAIT-MONOTRAIT RATIO)						
Variable	ES	GCR	GI	GPA	GRS	GTD
ES						
GCR	0.759					
GI	0.829	0.776				
GPA	0.714	0.940	0.768			
GRS	0.786	0.836	0.865	0.782		
GTD	0.722	0.889	0.809	0.839	0.878	

Table 4

DISCRIMINANT VALIDITY (FORNELL-LARCKER'S CRITERION)						
Variable	ES	GCR	GI	GPA	GRS	GTD
ES	0.801					
GCR	0.668	0.794				
GI	0.789	0.641	0.841			
GPA	0.611	0.847	0.647	0.869		
GRS	0.734	0.729	0.739	0.714	0.849	
GTD	0.665	0.787	0.691	0.764	0.793	0.874

Note: ES: Environmental sustainability; GCR: Green Recruitment and Selection; GI: Green Innovation; GPA: Green performance assessment; GRS: Green Recruitment and Selection; GTD: Green Training and Development.
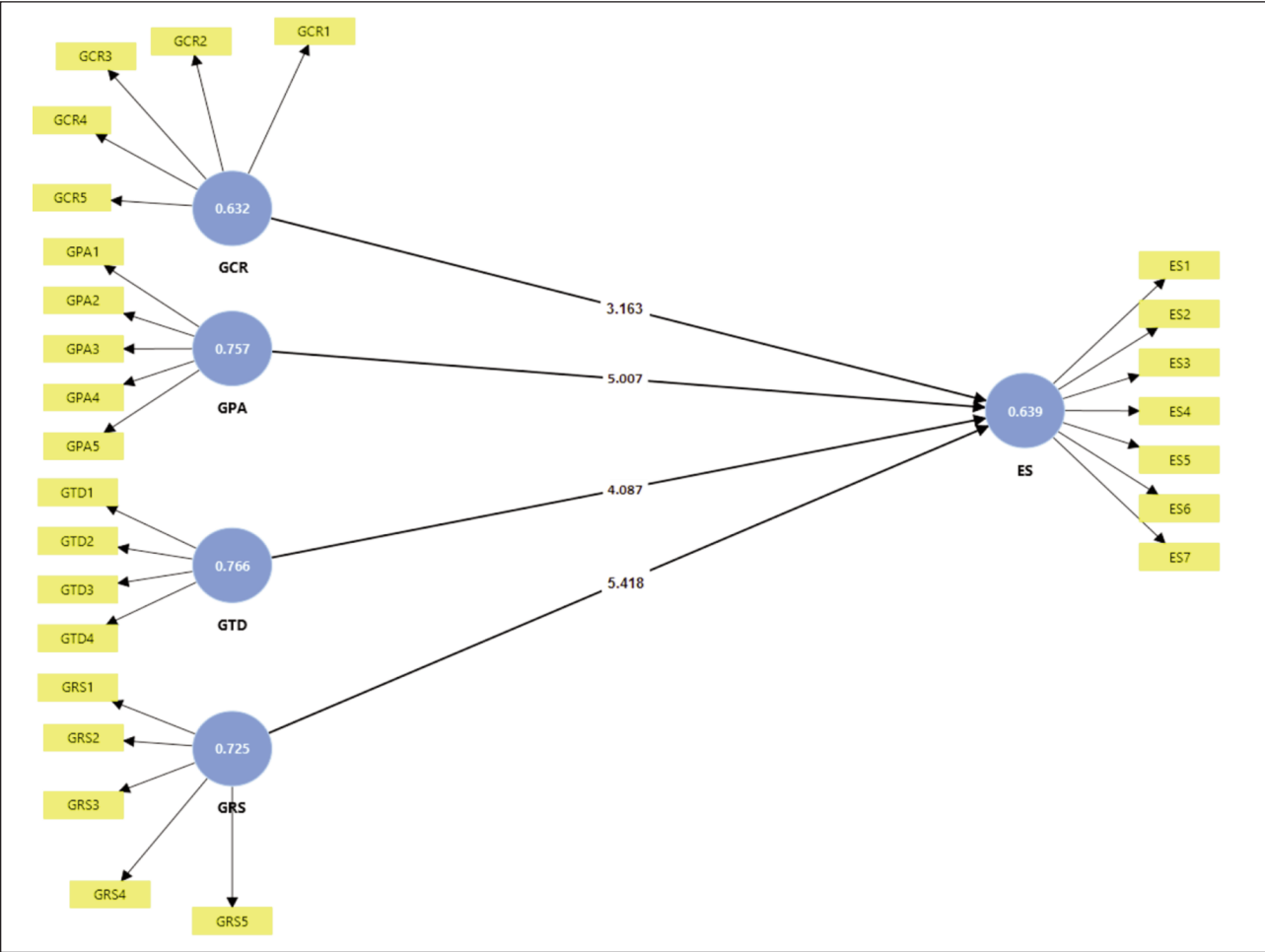
Fig. 2. The structural model for direct relationships (extracted from SmartPLS 4.0)

Standardised beta values indicate an indirect effect in regression analysis; t-values and beta values assess significance. Henseler et al. T-values above 1.64 are statistically significant and guide hypothesis decisions.

Hypothesis testing

Direct Relationships between the variables are shown in table 5. The structural model suggested that the strongest relationship was H3 between GRS and ES, the coefficient of this relationship was 0.385, while the mean of this relationship was 0.387, STDEV was 0.050. Lastly, the T-statistic and p-value were 4.186 and 0.028, respectively; this indicates a strongly positive and statistically significant and strong relationship. In contrast, the model suggests the weakest relationship was between hypothesis 02 between GPA & ES, which has a path coefficient of 0.184, a mean of 0.189, a standard deviation of 0.047, a T-statistic of 5.007, and a p-value of 0.003. Despite the high T-statistic indicating statistical significance, the lower path coefficient shows a moderate positive effect of GPA on ES and the hypothesis was also supported. Further, on behalf of the examination. All 04 hypotheses of this study were supported, and the relationships were statistically significant and contributed positively to Environmental sustainability, but GRS was more substantial than the other variables.

Table 5

HYPOTHESIS TESTING (DIRECT RELATIONSHIPS)						
Relationship	Path	Mean	STDEV	T-stat	p-values	Result
H1: GCR → ES	0.231	0.239	0.071	3.163	0.002	Supported
H2: GPA → ES	0.184	0.188	0.047	5.007	0.055	Supported
H3: GRS → ES	0.385	0.387	0.050	4.186	0.028	Supported
H4: GTD → ES	0.341	0.345	0.066	5.418	0.001	Supported

Note: ES: Environmental sustainability; GCR: Green Recruitment and Selection; GI: Green Innovation; GPA: Green Performance Assessment; GRS: Green Recruitment and Selection; GTD: Green Training and Development.

Table 6

MEDIATION RELATIONSHIP (HYPOTHESIS TESTING)							
Relationship	Path	Mean	STDEV	T-stat	p-values	Decision	Mediation Type
H5: GPA → GI → ES	0.450	0.454	0.080	4.867	0.002	Support	Partial mediation
H6: GRS → GI → ES	0.367	0.368	0.062	5.906	0.000	Support	Partial mediation
H7: GTD → GI → ES	0.322	0.324	0.066	3.857	0.001	Support	Partial mediation
H8: GCR → GI → ES	0.319	0.324	0.066	4.288	0.003	Support	Partial mediation

Note: ES: Environmental sustainability; GCR: Green Recruitment and Selection; GI: Green Innovation; GPA: Green Performance Assessment; GRS: Green Recruitment and Selection; GTD: Green Training and Development.
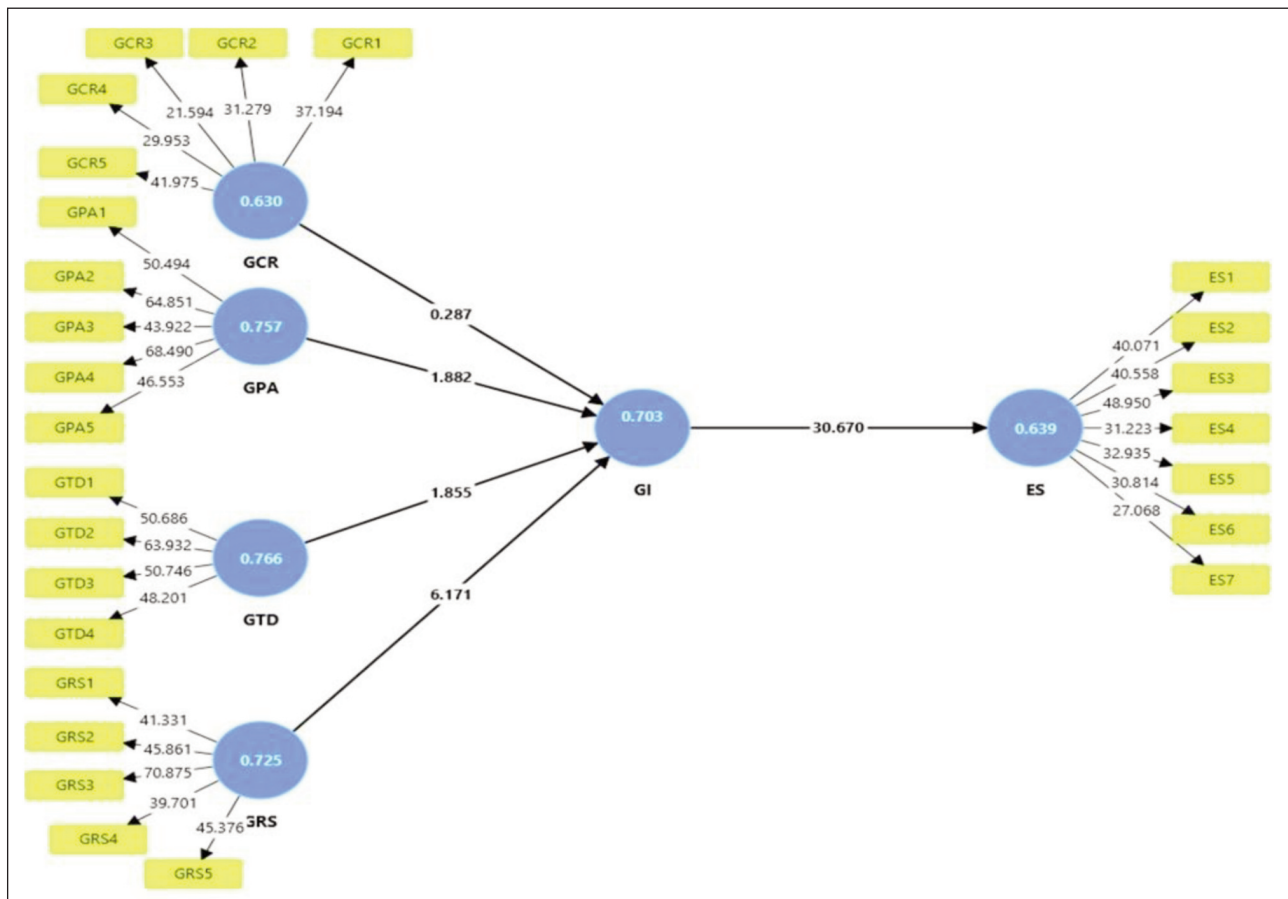

Fig. 3. The structural model for indirect relationships (extracted from SmartPLS 4.0)

About mediating effects, the analysis confirmed a mediating impact of GI in shaping the connection between GHRM Practices and ES. Table 6 demonstrates the correlation between GPA and ES (β=0.450, t-statistics=4.867, p<0.002).

The relationship between GRS and ES (β=0.367, t-statistics=5.906, p<0.000), GTD and ES (β=0.322, t-statistics=3.857, p<0.001) were positively and significantly mediated by GI. Additionally, GI positively and significantly mediated the relationships between GCR and ES (β=0.319, t-statistics=4.288, p<0.003). As a result, all hypotheses H5, H6, H7, and H8 are supported.

R2 values range from zero to one, as suggested by Chin [56], with 0.13 considered poor, 0.33 moderate, and 0.67 strong. The coefficient of determination for endogenous constructs is demonstrated in table 5, while figure 2 illustrates the PLS bootstrapping process.

Table 7

ASSESSMENT OF R^2 AND Q^2			
Variable	R^2	R^2 Adjusted	Q^2
GI	0.629	0.621	0.413
ES	0.588	0.583	0.355

Note: ES: Environmental Sustainability; GI: Green Innovation.

DISCUSSION AND CONCLUSION

This study aimed to address two key research questions: Do GHRM practices promote environmental sustainability in the context of HEIs? Second, does green innovation mediate the relationship between GHRM practices and environmental sustainability?

The data was collected from the textile and fashion design higher educational institutions (HEIs) in Pakistan's southeastern and second-largest province. The study confirms that GHRM practices are important in enhancing environmental sustainability. Moreover, findings reveal that all GHRM practices explored in this study were positively correlated with ES. All hypotheses of the study were significantly accepted. Among our hypotheses, Green Recruitment and Selection (GRS) had the most decisive impact on Environmental Sustainability (ES) (path coefficient = 0.385). It is suggested that institutions prioritising sustainability in their hiring processes are more likely to achieve better environmental outcomes; these results are linked with previous research of Jabbour [3] and Pham [5], who emphasised the strategic role of recruitment in embedding environmental values within an organisation. Moreover, the hypothesis regarding Green Compensations (GCR) and Green Training exhibited significant correlation with ES and supported the idea that incentivising and equipping employees with sustainable practices can improve environmental change. These results were consistent with the Daily et al. [48] study. The hypothesis of Green Performance Appraisal (GPA) showed a weaker correlation with ES (path coefficient = 0.184) and suggested that performance appraisals alone may not be as effective as more proactive measures like recruitment and training; these findings also align with Jabbour's [3] and Pham et al. [5] who assert that performance evaluations need to be complemented by broader organisational initiatives to be truly impactful in advancing sustainability. As the study's second objective, we studied the mediating relationship of Green Innovation between the GHRM and ES. It was observed that GI partially mediates the relationship, indicating the potential of GHRM and these practices not only directly influence sustainability but also create the environment for GI, which will contribute to long-term environmental sustainability. Our results were consistent with the findings of Awais-E-Yazdan and Aftab [41, 42], who also studied the GI and demonstrated that GI is a critical mediator in the relationship between GHRM practices and environmental sustainability. Furthermore, Hussain [46] showed that organisations with strong GHRM initiatives are more likely to foster green innovation, which leads to overall improved sustainability outcomes. Our study emphasises the importance of GHRM practices and incorporating GI in higher educational institutions to achieve environmental sustainability. It is suggested that HEIs must focus on the GHRM practices to create a virtuous cycle of engagement, innovation, and environmental stewardship. Furthermore, they can create an example within the educational sector, the industries they serve, and society. Although this study focused on higher educational institutions of one province, the findings may have broader applicability due to the common characteristics of academic institutions nationwide. We believe a similar relationship can be observed in other provinces, such as Punjab, Khyber Pakhtunkhwa, or Balochistan. Additionally, the generalizability of these results could extend to neighbouring countries due to the same culture. However, Future research could explore these practices in different geographical or cultural settings to confirm the applicability of the results.

Managerial implications

The findings of this study provide several important insights for managers. First, this study has demonstrated how underdeveloped countries, such as Pakistan, achieve environmental sustainability by implementing Green Human Resource Management (GHRM) practices. Secondly, higher education institutions (HEIs) have a significant role in mitigating environmental degradation along with their routine operations. It suggested that by integrating GHRM practices, HEIs can reduce their environmental footprint and serve as role models for other sectors to adopt sustainable practices. Therefore, administrators of HEIs must prioritise green recruitment, training, compensation, and performance appraisals within institutional processes. These practices will motivate employees and other stakeholders to embrace sustainability initiatives. That leads to long-term environmental sustainability. Secondly, we have found the critical role of green innovation in driving environmental sustainability. Our study demonstrated that green innovation significantly mediates the relationship between GHRM and environmental sustainability. Therefore, it is recommended that administrators and managers integrate green innovation into institutional operations, invest in sustainable technologies, and foster an innovation-driven culture that aligns with long-term sustainability goals.

LIMITATIONS

Despite the strengths of this study, certain restrictions must be acknowledged, creating avenues for future research. First, the study focuses exclusively on higher education institutions (HEIs) in Sindh, Pakistan. This narrow geographical scope may limit the generalizability of the findings to other regions or industries. Future studies should extend their scope to other key sectors or geographic areas, including cross-country comparisons, to enhance the applicability of results. Additionally, comparative studies between developed and developing regions could provide deeper insights into contextual influences on the effectiveness of Green HRM (GHRM) practices. Second, this study considers only Green Innovation as a mediating variable. Future research should explore additional mediators, such as Green Passion, Green Servant Leadership, Green Work-Life Balance, and STARA capabilities, to provide a more comprehensive understanding of the relationship between GHRM and environmental sustainability. Furthermore, due to time and resource constraints, this study does not examine the moderating effects of key constructs. Future researchers should investigate the role of potential moderators to derive more

nuanced and impactful conclusions. Third, using a cross-sectional research design limits the ability to establish causality. Longitudinal studies are needed to examine the long-term impact of GHRM on environmental sustainability and to establish more explicit cause-and-effect relationships. Finally, this study relies on survey data, employing a five-point Likert scale. While efficient, this method may not fully capture the nuanced perspectives of participants and introduces the possibility of response bias.

Future research should consider a mixed-method approach, incorporating qualitative techniques such as interviews and case studies. Additionally, gathering data from multiple stakeholders could provide a more holistic perspective and mitigate potential biases.

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Authors:

MUHAMMAD WAQAS NAZIR[1], SHEN ZUNHUAN[1], LIAQUAT ALI RAHOO[2]

[1]School of Economics and Management, Xidian University, China

[2]Mehran University of Engineering and Technology, Pakistan

Corresponding author:

MUHAMMAD WAQAS NAZIR
e-mail: Waqasxdu@gmail.com