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Towards a greener tomorrow: investigating the nexus of GHRM, technology innovation, and employee green behavior in driving sustainable performance

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ABSTRACT

In response to the global imperative to address climate change, organizations are increasingly pressured to reduce industrial waste, curb carbon emissions, and adopt environmentally responsible practices. This study aims to investigate the interplay between Green Human Resource Management (GHRM), technological innovation, and sustainable performance, with a focus on the moderating role of employee green behavior, within the manufacturing leather industry of Pakistan. According to the Resource-Based View (RBV) theory, a firm's competitive advantage arises from its unique bundle of internal resources and capabilities, rather than solely from external factors such as market positioning or industry conditions. The study population comprises top and middle management personnel from various roles within leather manufacturing firms, selected through cluster random sampling. A total of 525 questionnaires were distributed, of which 347 were deemed suitable for analysis. Utilizing SPSS version 25 and AMOS version 25 for hypothesis testing, the findings reveal a positive and significant relationship between GHRM, technological innovation, and sustainable performance. Employee green behavior moderates the relationship between GHRM, technological innovation, and sustainable performance, emphasizing individual actions' role in sustainability. This study offers insights into this nexus, highlighting direct and indirect effects, and provides practical guidance for policymakers and managers to enhance sustainable performance through environmental priorities and targeted interventions.

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1. Introduction

Human Resource Management (HRM) plays a pivotal role in guiding organizations through the complexities of modern business dynamics. The implications of HRM practices are profound and multifaceted, influencing every stage of an organization's journey. This continuous process presents significant challenges, as highlighted by Cohen et al. (2012). However, research suggests that adopting a cohesive set of HRM practices can significantly enhance productivity (Zaid et al., 2018). This is where the concept of Green Human Resource Management (GHRM) emerges as particularly relevant. In today's landscape, the management of green ecology stands out as a critical concern for organizations. Balancing the needs of both employees and customers becomes paramount, as the transition to environmentally sustainable practices can be met with resistance and insecurity among the workforce (Barry et al., 2009). By adopting the Resource-Based View (RBV) theory as a theoretical framework, this study aims to analyze how the unique combination of GHRM practices, technology innovation, and employee green behavior contributes to the sustainable competitive advantage of leather manufacturing firms in Pakistan. By identifying and leveraging valuable, rare, and non-substitutable resources, firms can enhance their environmental

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performance and long-term viability in an increasingly competitive market environment. Yet, the adoption and implementation of GHRM practices are imperative for businesses, as they offer numerous benefits. Not only do they enable organizations to reduce costs and improve work efficiency, but they also foster greater employee participation in achieving organizational objectives (Demir Uslu & Kedikli, 2017).

Furthermore, GHRM practices provide a structured framework that allows organizations to better manage their ecological impact. Sudin (2011) suggests that this strategic approach to HRM can lead to enhanced sustainability performance, positioning GHRM as a key strategy for organizations committed to long-term success. Research findings support the efficacy of GHRM practices in addressing environmental concerns while simultaneously improving organizational outcomes. Sheopuri and Sheopuri (2015) highlight how GHRM practices align with environmentally friendly initiatives, contribute to cost reduction efforts, enhance work efficiency, and promote employee retention and engagement. By reducing their carbon footprints through the adoption of GHRM practices, organizations can align with global sustainability goals while simultaneously improving their bottom line. Technological advancement has increasingly become integral to daily life, with the development and application of novel technological knowledge altering existing paradigms in various domains, including product and service expertise as well as organizational processes (Barge-Gil & López, 2014). Organizational innovation is propelled by technological innovation, which can be categorized into three levels based on the degree of independence: simple imitation, imitative innovation, and independent innovation. Technological innovation is predominantly examined through an economic lens, with ongoing efforts in economics to define and classify innovations (Coccia, 2019). Employees' environmentally friendly behavior refers to actions aimed at conserving natural resources, protecting the environment, and mitigating environmental degradation while enhancing environmental quality (Norton et al., 2015). Amid ongoing discussions about the societal role of businesses and the extent to which they should prioritize environmental concerns, many companies are integrating sustainability into their strategic implementation processes—a trend expected to persist in the coming years (Dmytriyev et al., 2021). Researchers and managers have recognized a multitude of factors influencing businesses' capacity to adopt sustainable practices (Elia et al., 2021). These factors include internal aspects like organizational culture, leadership, and employee attitudes, as well as external factors such as regulatory requirements, market dynamics, and stakeholder expectations. Additionally, Green Human Resource Management (GHRM) is pivotal in enhancing employees' sustainable capabilities (Trujillo-Gallego et al., 2022), particularly through integrating performance evaluation (Song et al., 2021; Zhang et al., 2023). However, there exists a gap in comprehending how GHRM effectively fosters employee engagement in eco-friendly behaviors to achieve sustainable outcomes.

Moreover, the manufacturing sector is recognized as a significant contributor to various forms of environmental pollution in both developed and developing countries, necessitating organizations to scrutinize, monitor, and rectify managerial practices (Rehman et al., 2016). Companies should invest in human capital to bolster their performance (Wang & Cuervo-Cazurra, 2017). Similarly, investing in Green Human Capital (GHC) is imperative for organizational development because employees' environmental knowledge and relevant skills significantly influence organizational performance (Yong et al., 2019a, 2019b). Across all organizational functions, employees bear responsibility for upholding an organization's green and environmental reputation (Jabbour & Santos, 2008; Opatha & Arulrajah, 2014). Consequently, managers must engage employees at every organizational stage to preserve the environment. HR managers are tasked with implementing GHRM practices to enhance sustainable performance. Therefore, this study investigates the correlation between GHRM practices and the impact of technological innovation on sustainable performance. Additionally, it explores the moderating effect of employee green behavior on the relationship between GHRM practices and sustainable performance, as well as the relationship between technological innovation and sustainable performance.

2. Theoretical frameworks

2.1. Resource-based view (RBV) theory

The Resource-Based View (RBV) theory, initially proposed by Wernerfelt (1984) and further developed by Barney (1991), posits that a firm's sustainable competitive advantage arises from its unique bundle of

resources and capabilities. According to RBV, to achieve sustainable performance, a firm must possess resources that are valuable, rare, difficult to imitate, and non-substitutable (Barney, 1991). Green Human Resource Management (GHRM) practices, such as employee training on environmental issues, green recruitment strategies, and eco-friendly workplace policies, represent valuable and rare resources that contribute to a firm's competitive advantage (Jackson et al., 2011). These practices enhance employee commitment, productivity, and innovation, thereby fostering a culture of sustainability within the organization. Technological innovations, including advancements in eco-friendly manufacturing processes and waste reduction technologies, serve as tangible resources that confer competitive advantages to firms (Teece et al., 1997). By investing in technological innovation, firms can enhance their operational efficiency, reduce environmental costs, and differentiate their products in the market (Porter, 1991). Furthermore, employee green behavior, such as energy conservation and participation in sustainability initiatives, represents a unique capability derived from the firm's human resources (Ren et al., 2018). This capability enhances the firm's environmental performance by promoting eco-friendly practices and reducing resource consumption (Dangelico & Pujari, 2010). Moreover, employee engagement in sustainability initiatives fosters a sense of organizational citizenship behavior, contributing to the firm's reputation and stakeholder relations (Nishii et al., 2008). Sustainable performance, encompassing economic, environmental, and social dimensions, reflects the successful integration of GHRM practices, technological innovation, and employee green behavior. Firms that effectively leverage these resources and capabilities can achieve superior performance in terms of profitability, environmental stewardship, and stakeholder satisfaction (Hart, 1995).

2.2. GHRM practices

Green Human Resource Management (GHRM) represents a significant paradigm shift in organizational management, integrating ecological considerations into traditional HRM practices. The concept, introduced by Shaaban (2024), highlights the dual potential of GHRM to enhance both environmental and financial performance. Unlike conventional HRM research, which primarily focuses on the impact of HRM on organizational effectiveness through employee attitudes and behaviors (Dumont et al., 2017), GHRM expands this discourse by examining the influence of organizational actions on sustainable performance (Nakra & Kashyap, 2024). Scholarly investigations into GHRM often adopt a holistic approach, emphasizing the collective impact of GHRM practices rather than analyzing individual practices in isolation (Nejati et al., 2017). This comprehensive perspective underscores the interconnectedness of various GHRM initiatives and their cumulative effect on environmental outcomes. Specifically, research in this field explores dimensions such as green hiring, green training and involvement, and green performance management and compensation. These green strategies not only benefit the environment but also yield positive outcomes for organizations and their employees. By mitigating adverse environmental impacts, organizations can enhance their reputation, reduce costs, and gain a competitive edge (Delmas & Pekovic, 2013). Additionally, employees are increasingly attracted to organizations that demonstrate a commitment to sustainability, which leads to improved morale, productivity, and retention rates. Thus, studying GHRM practices is crucial for understanding how organizations can align their HR strategies with sustainability objectives. Aligning HRM practices with the Resource-Based View theory emphasizes the strategic utilization of human capital to achieve sustained competitive advantage (Barney, 1991). By delving into the nuances of green HR practices, scholars and practitioners can identify strategies to foster sustainable performance while promoting organizational success and employee well-being.

2.2.1. Green hiring

Organizations committed to environmental sustainability must prioritize their hiring processes to attract individuals who not only comprehend but also actively engage in environmental protection initiatives. This requires a strategic focus on recruitment efforts, reflecting the growing awareness among prospective talent regarding environmental concerns (Ehnert, 2009a, 2009b). By aligning recruitment strategies with environmental values, organizations can cultivate a reputation for sustainable performance, projecting an image of genuine concern for the planet (Guerci et al., 2016). To effectively attract environmentally

conscious candidates, organizations should proactively promote their green vision, past environmental achievements, and policies through targeted advertisements. These advertisements should include comprehensive job descriptions that outline environmental responsibilities and detail the requisite skills and knowledge necessary to execute environmental tasks effectively (Chaudhary, 2019). Thus, green hiring emerges as a pivotal aspect of Green Human Resource Management (GHRM) practices, underscoring the importance of building a workforce equipped to address environmental challenges and enhance sustainable performance (Zibarras & Coan, 2015). In essence, integrating green hiring practices not only reflects an organization's commitment to environmental sustainability but also facilitates the recruitment of individuals who share these values. This approach fosters a culture of environmental responsibility within the workforce, aligning recruitment efforts with environmental goals to enhance the organization's sustainable performance and overall reputation as a socially and environmentally responsible entity (Shoaib et al., 2022).

2.2.2. Green training and involvement

Green Training and Implementation (GTI) has emerged as a cornerstone of organizational success, playing a pivotal role in fostering sustainable development (Pinzone et al., 2019). It serves as a critical enabler for the effective execution of green strategies (Jabbour et al., 2013) and the adoption of cleaner production practices (Diana et al., 2017). Consequently, organizations are increasingly compelled to embed social and environmental considerations into all facets of their employee training and development initiatives (Mandip, 2012; Mehta & Chugan, 2015). An essential aspect of this approach is the design of environmental training programs specifically tailored to optimize environmental benefits (Cherian & Jacob, 2012). Research underscores the significant impact of environmental training on an organization's sustainable performance (Bilderback, 2024). Encouraging staff participation in green initiatives not only enhances an organization's sustainable performance but also serves as a roadmap for aligning green objectives, bolstering motivation, and cultivating the necessary capabilities to address environmental challenges (Florida & Davison, 2001; Kitazawa & Sarkis, 2000). In essence, the integration of GTI into organizational practices represents a proactive response to the imperatives of sustainability. This integration emphasizes the need for holistic approaches that engage employees at all levels in driving environmental consciousness and action. By nurturing a culture of environmental responsibility through targeted training and participation initiatives, organizations can enhance their green image and fortify their capacity to navigate the complexities of contemporary environmental concerns (Zaid et al., 2018).

2.2.3. Green performance management and compensation

The imperative connection between an organization's environmental performance and its economic success has been emphasized by Stefan and Paul (2008). Tang et al. (2022) advocate for the adoption of green standards to enhance environmental performance. To effectively translate green strategies into tangible achievements, it is essential for organizations to strengthen their green reward systems, as posited by Jabbour and de Sousa Jabbour (2016). Their research indicates that incentivizing environmentally responsible behavior through such systems not only discourages negative practices but also fosters a culture conducive to eco-friendly actions (Zoogah, 2011). Various forms of rewards are utilized to cultivate green skills, encompassing both monetary incentives, such as bonuses, and non-monetary perks, such as leave entitlements and gifts (Opatha, 2013, Odhiambo et al., 2023). Furthermore, recognition-based rewards, like awards ceremonies and public commendations, play a crucial role in reinforcing environmentally conscious practices within organizational frameworks. Merriman and Sen (2012) underscore the critical role of green compensation in enhancing project sustainability and fostering staff dedication towards environmental objectives. Therefore, the integration of robust green reward systems emerges as a cornerstone for organizations committed to improving their sustainable performance.

2.3. Technology innovation

Teece (2010) posits that technological innovation encompasses three interconnected processes: the generation of scientific and technological knowledge, its translation into functional artifacts—such as products, systems, processes, and services—and the response to market demands. This process typically involves both product and process innovation. Product innovation refers to the introduction of goods or

services that are either novel or substantially enhanced in terms of specifications or intended uses. This includes improvements in technical aspects, components, materials, software integration, user experience, and other functional attributes (Tajpour et al., 2020, Sahoo et al., 2023). Conversely, process innovation involves the implementation of new or significantly improved production or transfer methods, which may entail substantial alterations in techniques, equipment, and/or software. The primary objectives of process innovation are to reduce production costs, enhance quality, or introduce new and significantly improved products (Ortigueira-Sánchez et al., 2022). The significance of technological advancement has increasingly permeated various facets of life, driven by the continuous generation and application of novel technological insights that reshape existing paradigms in product and service expertise, as well as organizational processes within companies (Barge-Gil & López, 2015). Organizational evolution is propelled by technological innovation, which can be categorized into three hierarchical levels based on the degree of autonomy: simple replication, imitative innovation, and autonomous invention. From the perspective of the Resource-Based View (RBV) theory, technological innovation emphasizes the strategic utilization of unique technological capabilities to attain sustained competitive advantage (Teece, 2007). Technological innovation is predominantly examined through an economic lens, with ongoing efforts in economics to define and classify innovations (Coccia, 2010; Pehrsson, 2016). The moral-economic perspective primarily focuses on interpreting innovation within the contexts of markets and corporate strategies. According to Subramani (2004), technological innovation involves adopting fresh concepts to develop novel products or services and restructuring organizational production processes or service operations, with the adoption process constituting the pivotal decision to embrace innovation as the optimal path forward (Higa et al., 1997). Indicators of technological innovation, as identified by Ambrogio et al., (2022), span various domains such as work equipment, automation and electronic processing, office applications and management information systems, and administrative information systems.

2.4. Employee green behaviour

The significance of green employee behavior within firms' environmental sustainability strategies is increasingly recognized, as employees often spearhead organizational change and profoundly influence a company's environmental performance (Malokani et al., 2023; Akram et al., 2024). Recent studies have delved into the correlation between green employee behavior and environmental strategy, underscoring the pivotal role of cultivating a culture of sustainability within organizations. Azizi et al. (2021) discovered that companies prioritizing sustainability in their organizational culture and offering environmental education and training to employees are more likely to witness favorable outcomes in terms of green employee behavior and overall environmental performance. Similarly, Yu et al. (2021) revealed that employee engagement in green initiatives, such as recycling programs and energy conservation efforts, can result in substantial reductions in carbon emissions and other environmental impacts. Organizational psychologists have conceptualized green employee behavior as a multifaceted performance domain encompassing a range of employee behaviors that either contribute to or detract from the collective organizational objective of advancing environmental sustainability (Steyn, 2024., Campbell & Wiernik, 2015). This construct intersects with established dimensions of work performance, including tasks, citizenship, counterproductivity, team members, and leadership performance (Ciocirlan, 2017). Additionally, scholars have proposed further forms of performance with environmental implications, such as adaptive, proactive, and sustainable performance. Employee green behavior can be understood as the manifestation of firm-specific resources and capabilities aimed at environmental sustainability, aligning with the Resource-Based View (RBV) theory (Barney, 1991). The relevance of green employee behavior may vary across different job roles within an organization, with some roles, such as a sustainability officer, being more directly tied to it than others, such as a supermarket cashier. Green Human Resource Management (GHRM) aims to establish a human resource management system that harmonizes with both internal and external environments. This system formulates strategies to aid companies in enhancing their environmental performance and promoting sustainable development. In today's context, GHRM is a burgeoning concept crucial for businesses looking to bolster their sustainability efforts and embrace eco-friendly practices (Jain et al., 2023; Peerzadah et al., 2018). Particularly in developing nations, researchers emphasize the pressing need to address human resource management practices and outcomes at both

organizational and individual levels (Shoaib et al., 2021; Yong et al., 2019a, 2019b). GHRM proves beneficial for organizations striving to achieve their environmental goals, as it fosters the development of employees' environmentally friendly behaviors.

2.5. Sustainable performance

Sustainable performance programs have become pivotal in assisting organizations to mitigate emissions, reduce greenhouse gases, minimize hazardous waste, and manage solid waste disposal effectively (Mousa & Othman, 2020). The implementation of green strategies has emerged as a critical driver for bolstering sustainable performance across various industries (Ullah et al., 2022; Rodriguez-Antón et al., 2012). In manufacturing organizations, specifically, prioritizing environmental concerns and allocating resources toward technological advancements aimed at pollution prevention have shown a strong correlation with improved sustainable performance (Miroshnychenko et al., 2017). Furthermore, the adoption of Green Human Resource Management (GHRM) practices has been identified as instrumental in augmenting sustainable performance outcomes (Singh et al., 2020). Research underscores the significance of investing in personnel development to enhance skills and capabilities for effectively managing sustainable performance (Hasan & Chowdhury, 2023). Employee engagement also emerges as a central tenet in driving sustainable performance initiatives within firms. Studies indicate that employees are more likely to align with organizations that demonstrate a commitment to environmental stewardship (Chan & Hawkins, 2010; Paillé et al., 2023). Previous research suggests that businesses should strive to optimize profit, enhance company performance, foster social cohesion, and preserve the natural environment simultaneously to achieve optimal outcomes across all levels (Montiel et al., 2021; Tsalis et al., 2020). As sustainable development garners increasing attention, businesses must meticulously strategize and articulate how their actions contribute to environmental and community well-being (Erkmen et al., 2020; Ozkan-Ozen et al., 2020). Sustainable performance, conceptualized within the Resource-Based View (RBV) paradigm, pertains to a firm's enduring competitive advantage achieved through the continual acquisition, development, and deployment of valuable, rare, and inimitable resources and capabilities (Peteraf, 1993). Green Human Resource Management (GHRM) represents the nexus between organizations' sustainable performance and their environmental, economic, and social impact (Malik et al., 2021). It denotes an organization's capacity to fulfill its business objectives and enhance shareholder value while considering long-term economic, environmental, and social responsibilities. Therefore, the present study investigates the following hypotheses:

H1: *GHRM Practices have positive effects on Sustainable Performance.*

H2: *Technology innovation has positive effects on Sustainable Performance.*

H3: *Employee green behaviour moderates the relationship between GHRM practices and Sustainable performance.*

H4: *Employee green behaviour moderates the relationship between technology innovation and Sustainable performance.*

3. Material and methods

3.1. Sampling design and data collection

This study adopts a positivist research methodology and employs an explanatory research framework to investigate the intricate dynamics of the manufacturing leather sector in Pakistan. The primary objective is to assess the influence of various variables on a carefully selected sample of top and middle management personnel within the industry. This study obtained ethical approval from the institutional review board of Pakistan Tanners Association, ensuring compliance with ethical standards and the protection of participant confidentiality and rights. The rationale for this selection is based on the assumption that these individuals possess a profound understanding of the sector's nuances and are well-versed in industry trends. The context of this study is defined by the rapid growth juxtaposed with the challenging economic conditions that the manufacturing leather sector in Pakistan has experienced in recent years.

Additionally, the sector operates in a highly competitive environment, further complicated by the formidable presence of global industry leaders. Pakistan's manufacturing landscape encompasses approximately 800 leather companies, though their distribution across the country is uneven. Production units are predominantly concentrated in three major cities: Karachi, Sialkot, and Faisalabad. Utilizing a cluster random sampling technique, the researchers endeavored to select a representative sample. The informed written and verbal consent was obtained from all participants prior to their involvement in the study. This process involved the dissemination of 525 online survey links, with 175 questionnaires sent to companies in each of the aforementioned cities. Subsequently, thirty leather firms were randomly selected from each city to participate in the survey. Out of the total distributed questionnaires, 367 were successfully collected, reflecting a commendable response rate of 69.90%. However, preliminary scrutiny revealed that 20 responses had to be excluded due to either missing values or the presence of outliers. Consequently, 347 questionnaires were deemed eligible for inclusion in the subsequent data analysis phase of the study.

3.2. Research instrument

This study employed established measurement scales from prior research to evaluate various constructs. Each item within these constructs was rated on a five-point Likert scale, ranging from '1' (strongly disagree) to '5' (strongly agree), consistent with the methodology utilized by Shoaib et al. (2022). Green human resource management (HRM) practices were assessed using a scale consisting of 15 items, categorized into three dimensions: green hiring, green training and involvement, and green performance management and compensation, adapted from Jabbour (2011). Furthermore, the moderating factor of employee green behavior was measured using a 12-item scale originally developed by Dumont et al. (2017). Technology innovation was measured with a five-item scale adapted from Subramani (2004), while sustainable performance was evaluated using a six-item scale adapted from multiple sources, including Rao (2002), Zhu et al. (2008), and Yong et al. (2019a, 2019b).

3.3. Analysis strategy

A two-stage multivariate data analysis was conducted using IBM-SPSS-AMOS 25, grounded in a theoretical framework. The study encompassed three latent constructs: Green Human Resource Management (GHRM) practices, technology innovation, and sustainable performance, with employee green behavior serving as a moderating variable. GHRM practices were conceptualized as a higher-order construct and were initially subjected to confirmatory factor analysis to validate the measurement model. This process involved assessing convergent, construct, and discriminant validity, including the calculation of composite reliability as per the guidelines of Awang (2015) and Rehman et al. (2021). The validation of the measurement model necessitated the attainment of concurrent, construct, and discriminant validity for the latent constructs. In the subsequent stage of analysis, structural equation modeling (SEM) was employed to investigate the interrelationships among GHRM practices, technology innovation, and sustainable performance.

4. Results

4.1. Demographic data of the participants

An analysis was conducted on a total of 367 valid responses to assess demographic characteristics including gender, age, qualification, designation, and experience. The results revealed a pronounced gender disparity, with males constituting 80.1% of the respondents, while females represented only 18.9%. The age distribution indicated that the majority of respondents were in the 30-40 age bracket (47.5%), followed by those aged 40-50 (34.9%). Smaller cohorts were observed for individuals under 30 (7.8%) and those over 50 (9.8%), highlighting a concentration of participants in their prime working years, particularly in their thirties and forties. Regarding professional designations, HR Executives comprised the largest group (53.6%), followed by HR Managers (19.4%) and Senior HR Managers (12.9%). This

distribution suggests a substantial representation of HR professionals across various hierarchical levels within the sample. Experience levels varied among respondents, with approximately half having less than 5 years of experience (48.7%). This was followed by those with 6-10 years (22.5%), 11–15 years (19.3%), 16–20 years (6%), and over 21 years (3.5%) of experience in leather manufacturing firms. These findings are detailed in Table 1.

4.2. Measurement model

The theoretical framework comprises three latent constructs: GHRM practices, technology innovation, and sustainable performance, with employee green behavior as the moderating variable. These constructs were incorporated into the measurement model to evaluate one-dimensionality, construct validity, convergent validity, discriminant validity, and composite reliability before applying SEM (Awang, 2015). All adjustments and criteria for the measurement model were met, as indicated by the fitness indices: P-value = 0.00, RMSEA < 0.059, CFI > 0.972, TLI > 0.968, and ChiSq/df = 2.442, which is <3. Upon meeting these threshold values, construct validity is considered achieved. Convergent validity is assumed when the average variance extracted (AVE) exceeds 0.5, and composite reliability (CR) surpasses 0.6, replacing Cronbach's alpha for multivariate analysis in SEM (Kashif et al., 2015, 2016). Table 2 presents factor loadings, AVE, and CR values. GHRM practices achieved an AVE of 0.686 and CR of 0.867, technology innovation attained an AVE of 0.695 and CR of 0.919, employee green behavior reached an AVE of 0.688 and CR of 0.964, and sustainable performance garnered an AVE of 0.683 and CR of 0.928. Meeting these relative AVE and CR values confirms convergent validity at the specified threshold levels for all constructs.

When a model achieves convergent validity, it must also exhibit construct validity. This requires satisfying the threshold values for model fitness, encompassing absolute fit, incremental fit, and parsimonious fit indices, as specified in Table 3, along with the corresponding values attained for all three categories of modification indices (Rehman et al., 2020).

Assessing discriminant validity within the measurement model is essential to ensure the non-redundancy of constructs. Redundancy arises when items within the model exhibit high correlations. Table 4 provides a summary index for evaluating discriminant validity. The diagonal and bolded values represent the square root of the Average Variance Extracted (AVE) for each construct, while the other values represent the correlation coefficients between the constructs. A correlation coefficient exceeding 0.85 indicates significant multicollinearity within the model. If no correlation coefficient surpasses this threshold, discriminant validity is confirmed, as demonstrated in Table 4. Ensuring that no pair of items in the

Table 1. Demographic profile.

Demographic variable	Characteristics	Frequency	Percentage (%)
Gender	Male	278	80.1%
	Female	69	18.9%
	Total	*347*	*100%*
Age	Under 30	27	7.8%
	30-40	165	47.5%
	40-50	121	34.9%
	Above 50	34	9.8%
	Total	*347*	*100%*
Designation	Director	07	2%
	General Manager	15	4.3%
	Operational Manager	27	7.8%
	Senior HR Manager	45	12.9%
	HR Manager	67	19.4%
	HR Executive	186	53.6%
	Total	*347*	*100%*
Work Experience	Less than 5 years	169	48.7%
	6—10 years	78	22.5%
	11—15 years	67	19.3%
	16 – 20 years	21	6%
	More than 21 years	12	3.5%
	Total	*347*	*100%*

N = 347, Source: Authors' field survey February 2024– April 2024.

Table 2. The value of average variance extracted (AVE) and composite reliability (CR).

Construct	Component	Factor Loading	AVE (value > 0.5)	CR (value > 0.6)
GHRM practices	GH	0.76	0.686	0.867
	GTI	0.87		
	GPC	0.85		
Technological innovation	TechI1	0.76	0.695	0.919
	TechI2	0.91		
	TechI3	0.79		
	TechI4	0.88		
	TechI5	0.82		
Employee green behavior	EGB1	0.83	0.688	0.964
	EGB2	0.87		
	EGB3	0.81		
	EGB4	0.89		
	EGB5	0.79		
	EGB6	0.76		
	EGB7	0.76		
	EGB8	0.91		
	EGB9	0.79		
	EGB10	0.88		
	EGB11	0.82		
	EGB12	0.83		
Sustainable performance	SUSP1	0.83	0.683	0.928
	SUSP2	0.87		
	SUSP3	0.81		
	SUSP4	0.89		
	SUSP5	0.79		
	SUSP6	0.76		

Table 3. The three categories of model fit and their level of acceptance.

Category	Index	Acceptance criterion	Achieved value
Absolute fit	RMSEA	RMSEA < 0.08	0.059
Incremental fit	CFI	CFI > 0.90	0.972
	TLI	TLI > 0.90	0.968
Parsimonious fit	ChiSq/df	ChiSq/df < 3.0	2.442

Table 4. The discriminant validity index summary for all constructs.

Construct	GHRM practices	Technology innovation	Employee green behaviour	Sustainable performance
GHRM practices	**0.828**			
Technological innovation	0.56	**0.833**		
Employee Green behaviour	0.33	0.21	**0.829**	
Sustainable performance	0.39	0.19	0.32	**0.826**

measurement model exhibits excessive correlation substantiates the distinctiveness of each construct, which is crucial for robust statistical analysis.

4.3. Structural model

Following the validation of the measurement model, the study advanced to the structural equation modeling (SEM) stage. In this phase, both exogenous and endogenous constructs were integrated within a structural model to assess causal relationships and regression coefficients, following the guidelines established by Awang (2015). By linking the two exogenous constructs and one endogenous construct, the analytical parameters were specified, and SEM was employed to estimate the path analysis. This model encompassed two paths, each characterized by the estimated loading values derived from the SEM process, as presented in Table 5.

The analysis reveals that Green Human Resource Management (GHRM) practices and Technological Innovation jointly explain 69% of the variance in Sustainable Performance, as indicated by the coefficient of determination (R^2). Table 6 provides the estimates of the unstandardized regression coefficients, illustrating the causal relationships among the variables. Both hypotheses (H1 and H2) were tested and confirmed, as shown in Table 6. The findings indicate that GHRM practices have a significant positive effect

Table 5. The coefficient of multiple determination or R2 and its implication in this study.

Endogenous Construct	R2	Conclusion
Sustainable Performance	0.69	The constructs of GHRM practices and Technological Innovation estimate about 69 percent of the variation in Sustainable Performance.

Table 6. Unstandardized regression estimation.

Predictor variable	Dependent variable	Estimate	S.E	C.R	*p*	Result
GHRM practices	Sustainable performance	.443	.057	8.433	.001	Significant
Technological innovation	Sustainable performance	.432	.067	7.362	.001	Significant

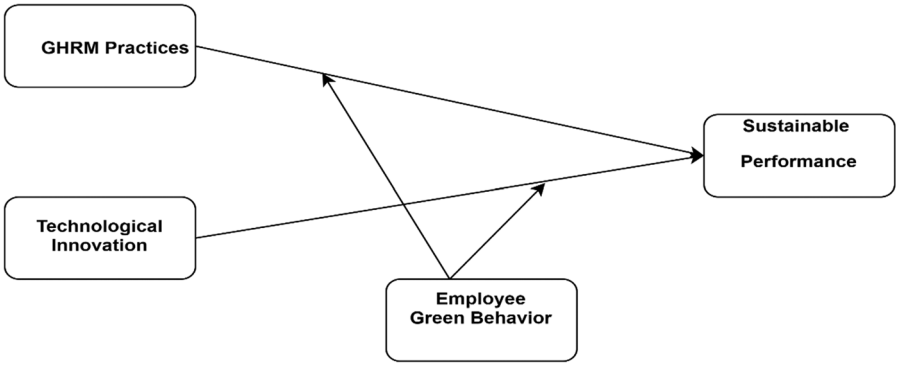

Figure 1. Theoretical framework.

on Sustainable Performance (β = 0.443, $p < 0.001$). Similarly, Technological Innovation also demonstrates a significant positive impact on Sustainable Performance (β = 0.432, $p < 0.001$), as depicted in Figures 1 and 2.

4.4. Moderation & simple main effects (employee green behavior moderating role between GHRM practices and sustainable performance)

In an analysis conducted using IBM-SPSS-25, the moderation of a metric variable was examined to understand the relationship between Green Human Resource Management (GHRM) practices, employee green behavior, and sustainable performance. The initial focus was on the direct impact of GHRM practices on sustainable performance, which was found to be statistically significant (F = 10.234, $p < 0.001$). This result highlights the critical role of GHRM practices in promoting sustainable outcomes within organizational settings. Beyond the direct effects, the study investigated the interaction between GHRM practices and employee green behavior on sustainable performance. This interaction term was statistically significant (β = 0.107, t = 2.092, $p < 0.05$), suggesting that the effectiveness of GHRM practices on sustainable performance is moderated by the level of employee green behavior. To further explore this interaction, the methodology proposed by Aiken and West (1991) was employed. This involved segmenting the dataset based on levels of employee green behavior, resulting in distinct groups categorized as low and high. Subsequent analysis provided detailed insights into the varying impact of GHRM practices on sustainable performance across these groups. Consistent with theoretical predictions, GHRM practices exhibited a significantly positive effect on sustainable performance in contexts where employee green behavior was high (β = 0.492, t = 5.012, $p < 0.001$). This indicates that when employees demonstrate a strong commitment to environmentally responsible behavior, the implementation of GHRM practices substantially enhances their contribution to sustainable outcomes. Conversely, even in scenarios where employee green behavior was less pronounced, GHRM practices still positively influenced sustainable performance (β = 0.312, t = 2.421, $p < 0.001$). However, the magnitude of this effect was lower compared to contexts characterized by high levels of employee green behavior. This finding underscores the importance of employee attitudes and behaviors in amplifying the impact of GHRM practices on sustainable performance. The observed difference in the slopes between high and low levels of employee green behavior

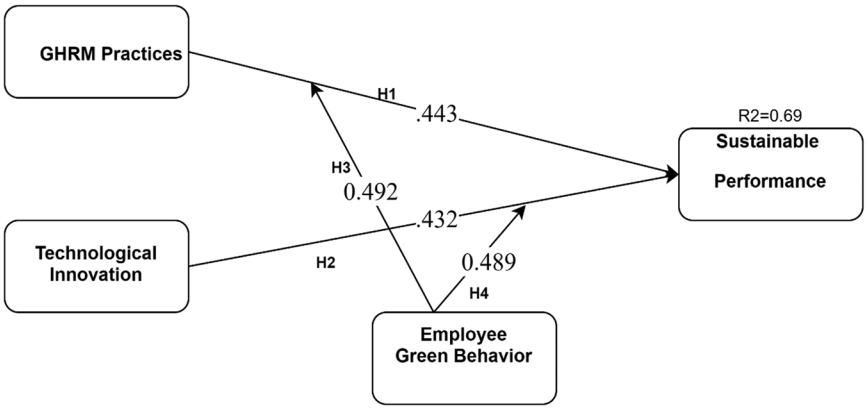

Figure 2. Confirmation of the research model.
Source: Author(s).

Table 7. The hypothesis testing for direct effect hypotheses.

Hypotheses	*p*-value	Result
H1: GHRM practices have significant positive impacts on sustainable performance.	0.001	Supported
H2: Technological Innovation has significant positive impacts on Sustainable Performance.	0.001	Supported
H3: Employee green behavior moderates GHRM practices and sustainable performance.	0.001	Supported
H4: Employee Green behavior moderates technological innovation and sustainable performance.	0.001	Supported

further supports the significance of this interaction (t = 3.56; $p < 0.001$), providing empirical validation for the hypothesized relationship (H3). This comprehensive analysis elucidates the complex interplay between GHRM practices, employee behavior, and sustainable performance, underscoring the necessity for organizations to cultivate both supportive HR practices and environmentally conscious employee behaviors to optimize sustainable outcomes.

4.5. Moderation & simple main effects (employee green behavior moderating role between technological innovation and sustainable performance)

In the exploration of the moderation of a metric variable, a critical statistical tool employed was the examination of interaction effects in IBM-SPSS-25. This analysis aimed to elucidate the influence of Technology Innovation, as the independent variable, on Sustainable Performance, the dependent variable, while considering the moderating impact of Employee Green Behavior. Initially, the direct causal relationship between Technology Innovation and Sustainable Performance was determined to be statistically significant (F = 11.119, $p < 0.001$). Concurrently, the interaction effect between Technology Innovation and Employee Green Behavior on Sustainable Performance was also found to be statistically significant (β = 0.109, t = 2.184, $p < 0.05$). Upon establishing the significance of the interaction term, the subsequent step involved probing into the nature of this interaction effect, following the methodology advocated by Aiken and West (1991). This entailed stratifying the dataset of moderating variables into low and high groups using dummy variables. Within each group, the impact of Technology Innovation on Sustainable Performance was assessed. As hypothesized, Technology Innovation exerted a positive influence on Sustainable Performance in both scenarios: when Employee Green Behavior was high (β = 0.511, t = 4.112, $p < 0.001$), and when it was low (β = 0.489, t = 3.886, $p < 0.001$). Notably, the effect was not significantly greater in the high Employee Green Behavior condition. Further analysis revealed a significant disparity between the slopes of the two regression paths representing high and low levels of Employee Green Behavior (t = 4.66; $p < 0.001$), reinforcing the findings and supporting Hypothesis 4. This insight underscores the nuanced interplay between Technology Innovation and Employee Green Behavior in shaping Sustainable Performance. Table 7 presents the model's output for both regression paths, providing a comprehensive overview of the relationships under scrutiny. Importantly, the determination of hypothesis acceptance or rejection was contingent upon the probability value (p-value), with hypotheses upheld when the obtained p-value was less than the predetermined significance threshold (alpha) of 0.05. This meticulous approach ensures robustness in drawing conclusions from the statistical analyses conducted.

5. Discussion

This study aimed to assess the impact of Green Human Resource Management (GHRM) practices and technological innovation on sustainable performance within the leather sectors of Pakistan. Additionally, it sought to examine how employee green behavior influences the relationship between GHRM practices, technology innovation, and sustainable performance. By presenting a structured framework, this research proposes a practical tool for leather firms' managers to evaluate sustainable performance by considering both employee green behavior and the application of GHRM practices within their sector. The findings of this study are presented through various hypotheses, which offer insights and strategic directions tailored to the leather firms in Pakistan. One key finding is that GHRM practices play a significant role in enhancing sustainable performance. This aligns with prior research by Isaac Ahakwa et al. (2021) and Abdelhamied et al. (2023), who emphasized the importance of fostering a culture of environmental consciousness within organizations. They argue that training and nurturing employees to embrace green initiatives are crucial for improving sustainable performance. The positive relationship observed between GHRM practices and sustainable performance suggests that organizations can benefit from adopting green HR practices, not only in terms of environmental impact but also in improving their overall efficiency and market competitiveness. Furthermore, the study establishes a direct positive relationship between technological innovation and sustainable performance, echoing the findings of Baeshen et al. (2021); Abbas et al. (2019). This supports the notion that advancements in technology, particularly those aimed at reducing environmental impact, are critical for organizations seeking to improve their sustainability. It suggests that technological advancements not only drive environmental improvements but also contribute to enhancing overall sustainability within organizations. Moreover, the study explores the moderating effect of employee green behavior on the relationship between technology innovation and sustainable performance. It reveals that higher levels of employee green behavior amplify the impact of both GHRM practices and technological innovation on sustainable performance. The results indicate that the effectiveness of GHRM practices and technological innovation in promoting sustainable performance is significantly enhanced when employees are actively engaged in environmentally friendly behaviors. This finding corroborates with the research conducted by Akram et al. (2024); Yu et al. (2021), emphasizing the pivotal role of employee engagement and commitment to green initiatives in maximizing the benefits of technological innovation for sustainable development. This study In line with the Resource-Based View (RBV) theory, underscores the importance of integrating GHRM practices, technological innovation, and fostering employee green behavior to enhance sustainable performance in the leather firms of Pakistan. The proposed framework and findings provide valuable insights and actionable strategies for industry practitioners to promote sustainability within their organizations.

5.1. Theoretical implications

This study makes a significant contribution to the field of Green Human Resource Management (GHRM) by affirming the Resource-Based View (RBV) theory, providing empirical evidence of its positive impact on sustainable performance within the leather manufacturing sector. It corroborates prior research by Isaac Ahakwa et al. (2021) and Abdelhamied et al. (2023), demonstrating the crucial role of GHRM practices in fostering environmental awareness within organizations. Furthermore, the research establishes a direct correlation between technological innovation and sustainable performance, resonating with findings from studies by Baeshen et al. (2021) and Abbas et al. (2019), thereby reinforcing the linkage between technological advancement and organizational sustainability. The positive relationship between technological innovation and sustainable performance provides further support for the RBV theory. It highlights the importance of technological capabilities as a key resource that can drive competitive advantage in the manufacturing sector. Additionally, the study elucidates the moderating influence of employee green behavior on the relationship between GHRM practices, technological innovation, and sustainable performance. This underscores the significance of individual actions in shaping organizational environmental outcomes, aligning with insights from Akram et al. (2024) and Yu et al. (2021). This finding adds a new dimension to the RBV theory by highlighting the importance of individual employee behaviors as a critical component of a firm's resource base. By exploring the interplay between GHRM, technological

innovation, and sustainable performance, this research addresses a critical gap in the intersection of HRM, technology management, and sustainability literature. It offers interdisciplinary perspectives on how these domains converge and impact organizational success, thereby enriching our theoretical understanding.

5.2. Managerial implications

In the leather manufacturing sector, it is imperative for managers to adopt Green Human Resource Management (GHRM) practices, with a particular focus on employee training and support for eco-friendly initiatives. As suggested by Isaac Ahakwa et al. (2021) and Abdelhamied et al. (2023), These practices not only improve environmental performance but also contribute to employee motivation and organizational commitment, which are crucial for long-term success. Furthermore, investing in innovative technologies to reduce industrial waste and carbon emissions, as advocated by Baeshen et al. (2021) and Abbas et al. (2019), demonstrates a direct positive correlation between technological innovation and sustainability. Managers should prioritize investments in eco-friendly technologies, as these can lead to significant improvements in both environmental and operational performance. To maximize the efficacy of GHRM and technological advancements, management should incentivize and recognize green behavior among employees, aligning with the findings of Akram et al. (2024) and Yu et al. (2021). For practitioners, this emphasizes the need to foster a culture of environmental responsibility within the organization. Managers should implement strategies to encourage and reward green behaviors among employees, as this can significantly amplify the benefits of GHRM practices and technological innovations Saeed et al. (2019). By integrating these practices, managers can develop tailored sustainability strategies, ensuring organizations maintain a competitive edge in the market while optimizing environmental performance. This approach is consistent with the Resource-Based View (RBV) theory, which emphasizes leveraging organizational resources for competitive advantage.

5.3. Future research directions

To extend the findings of this study, future research avenues should explore cross-industry comparative analyses. Investigating the interrelationships between Green Human Resource Management (GHRM) practices, technological innovation, and sustainable performance across various sectors can reveal nuanced insights, guided by the Resource-Based View (RBV) theory. Additionally, longitudinal studies are recommended to examine the evolving impacts of GHRM practices and technological innovation on sustainable performance over time. Such longitudinal analyses can illuminate the enduring sustainability outcomes of organizational initiatives. Qualitative research methods, such as interviews and focus groups, are promising for gaining deeper insights into the mechanisms through which GHRM practices, technological innovation, and employee green behavior influence sustainable performance. These methods can uncover the intricate dynamics within organizational settings. Furthermore, comparative studies across different countries or regions can elucidate the contextual factors that shape the effectiveness of GHRM practices and technological innovation in promoting sustainable performance. The variations in environmental regulations and cultural norms provide a fertile ground for understanding how contextual factors influence these dynamics. Moreover, future research should explore additional mediating and moderating factors that affect the relationships between GHRM practices, technological innovation, and sustainable performance. Factors such as organizational culture and government policies are likely to exert significant influences in this regard. Addressing these limitations and pursuing these research directions can deepen scholarly understanding of the intricate interplay between GHRM practices, technological innovation, and sustainable performance within organizational contexts.

Authors' contributions

Muhammad Shoaib: conceptualization, data curation, formal analysis, software development, methodology, and initial draft writing. Nosheen Qadeer: validation, investigation, writing, review, editing. Roman Zámečník: visualization, writing, methodology, software development and supervision.

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Data availability statement

The data presented in this study are available on request from the corresponding author.

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