Unveiling the Green Synergy: Exploring the Mediated Moderation Effect of Technological advancement and Green Process Innovation on GHRM and Sustainable Performance.

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Abstract

There is limited study on the relationship between green human resource management (GHRM), green process innovation (GPI), technological advancement (TA), and green sustainable performance (GSP), particularly in hospitality industries. This research study fills a knowledge gap by investigating the effects of GHRM on green sustainable performance and mediating effect of green process innovation. Furthermore, this also examined moderating role of technological advancement in hospitality industries. The purpose of this study was gained used a quantitative approach and a pre-tested scale. 390 individuals from hospitality industries were selected through simple random sampling. According to findings of the study, GHRM has significantly and positively influenced green sustainable performance. Similarly, green process innovation mediates the relationship between GHRM and GSP. Additionally, technological advancement significantly moderates the relationship between GPI and GSP. The findings have important implications for hospitality industries, researchers and practitioners, especially those working in hotels, and travels agencies. Study limitations and future research direction are also mentioned.

Keywords: GHRM, sustainable performance, technological advancement, green process innovation, hospitality industries

Introduction

GHRM is an approach to human resource management that combines environmental management practices with the goal of increasing sustainable performance in businesses by encouraging environmentally conscious actions in employees (Ahmad et al., 2024). Sarfraz et al. (2022) found that firms may achieve their sustainability goals by using green recruitment, training, and reward

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systems. These systems help to reduce environmental effect of the company. According to Vangeri et al. (2024), GHRM is essential for services industries since they need to implement innovative waste-reduction and green methods to solve environmental challenges. According to Al-Alawneh et al. (2024), and Sharma et al. (2020), GHRM assists organizations in implementing sustainable business practices that protect the environment and boost performance via the development of an environmentally conscious workforce. According to Xu et al. (2024), "green sustainable performance" refers to an organization's adoption of environmentally friendly practices in order to attain social, environmental, and economic sustainability. As environmental concerns throughout the world develop, there is an increasing need for businesses to enhance their environmental performance while preserving their profitability (Ritchie et al., 2020). This is particularly true in sectors like manufacturing that produce waste. Businesses must emphasize green sustainable performance, which includes energy efficiency, pollution reduction, and the use of renewable resources, if they want to improve their sustainability over the long run (Anser et al., 2020). Businesses in developing nations, such as Pakistan, are under increasing pressure to adopt sustainable practices in order to improve their environmental performance (Shahzad et al., 2024; Nazir et al., 2024; Khattak et al., 2021). To improve a company's long-term environmental performance, green process innovation is a crucial link in the chain. GPI creates and executes strategies to lessen the impact on the environment by recycling waste and cutting down on energy use (Kivimaa & Kautto, 2010). According to Segun-Falade et al. (2024), green process innovations may help businesses meet regulatory requirements, boost operational efficiency, save costs, and improve sustainability performance. According to Ahmad et al. (2024), GPI is crucial for sustainable manufacturing since it helps companies achieve their environmental goals and optimize resources more easily while decreasing their environmental effect. Green initiatives may find a way to long-term success with the help of new technologies. Businesses may now reduce their environmental effect without sacrificing operational efficiency because to the fast progress of green technology. This technology includes sensors that increase energy and waste efficiency (Anser et al., 2020). To ensure a company's long-term sustainability, it is crucial to carefully incorporate new technology into existing sustainability activities (Parekh & Wright, 2024). The use of new technology is crucial for the effective execution of green projects in nations like Pakistan, where the manufacturing sector faces substantial environmental obstacles. Organizations may improve their environmental performance, decrease waste, and install energy-efficient solutions via technological innovation, which is crucial for sustainability (Eckstein et al., 2021). This study used a mediated moderation technique to explore the connection between technological advancement, green process innovation, and green HRM in relation to improving the ecologically sustainable performance of different industries. According to Shahzad et al. (2020) and Kivimaa and Kautto (2010), GHRM improves sustainability performance. To improve environmental health, Kivimaa and Kautto (2010) highlighted GPI as a vital aspect. The fact that these developments may assist companies in lessening their negative effects on the environment is another reason for their praise (Anser et al., 2020). Few studies have examined how these elements interact with one another within the framework of Khyber Pakhtunkhwa hotel and tourism industries. This study used a mediated moderation paradigm to better understand how GHRM, GPI, and technological improvements contribute to improving green sustainable performance.

Review of Literature
Green HRM and Green sustainable performance
In the last decade, Green human resource management (GHRM) has become an important strategy for companies to target and gain firm sustainable performance, specifically, in hospitality industries i.e., hotels and travel agencies. According to Sarfraz et al. (2022), climate change and

environmental deterioration are forcing companies to rethink their operations. The green human resource management (GHRM) movement is leading the way. Tanveer et al. (2024) define Green Human Resource Management (GHRM) as implementing environmentally friendly practices into HR policies, programmes, and procedures to align business goals with sustainability. Hasan and Tanveer et al. (2024) believe this integration is necessary to implement environmentally friendly practices across the organization and include sustainability into every decision. They consider this integration essential. GHRM's financial incentives, educational opportunities, and environmental dedication may lead to sustainable performance. Yafi et al. (2021) discovered that Green Human Resource Management (GHRM) training improved environmental awareness. The training program teaches professionals how to identify and implement environmentally friendly methods. You may see initiatives to employ ecologically friendly products and services, decrease garbage, and improve energy efficiency. According to Tanveer et al. (2023), educated and environmentally friendly personnel increase organization and environment performance. Green Human Resource Management (GHRM) promotes an organization's values by emphasizing sustainability in HRM operations. This method promotes business values. Environmental sustainability-focused candidates are prioritized in hiring. This is the main topic of "recruitment." This coordinated effort helps the organization meet its environmental goals since its personnel are ecologically conscious. Human resources should be employed to analyses environmental performance to promote sustainability, according to Rahman et al. (2023). Sustainable approaches include green performance assessment and acknowledging sustainability-promoting behaviors. Worker efforts to promote environmental sustainability have shown outcomes.

The Guiding Principles for Responsible Management encourage innovations and process improvement that may improve environmental performance. Green HR policies often encourage workers to think creatively about how their organization may reduce its environmental effect. We do this to reduce pollution. Academics and tourism experts, particularly those affiliated with travel corporations, are crucial to the conclusions. Other criteria for classifying innovation include sustainability, increasing demand, and waste reduction. Tahir et al. (2024) argue that Human Resource Management (GHRM) encourages employee innovation to help the company meet its environmental goals. This helps the company meet its environmental objectives. General Human Resource Management (GHRM) and innovation are vital since new environmentally friendly practices may boost corporate productivity and lifespan. General Human Resource Management (GHRM) is as important as internal sustainability measures for external assessments. Businesses may show their environmental care and gain a competitive advantage by adopting greenhouse gas reduction laws (GHRM). This may be done by showing environmental awareness. A better public perception of the company, more brand-loyal consumers, and more investors interested in environmentally responsible financial investments are possible outcomes (Irani et al., 2022). All these possibilities are plausible. A high sustainability reputation may boost a company's green sustainability in several ways. The firm may increase sales, enter green markets, and involve stakeholders. Finally, the Global Human Resource Management (GHRM) program helps organizations comply with a new sustainable regulation. Companies having a thorough GHRM framework may find it simpler to meet global management environmental standards. As these restrictions tighten, some enterprises may find it simpler to comply. Sustainability in HR management reduces non-compliance risk and costs. According to Faisal (2023), this ensures all departments and individuals follow the law. According to Darvishmotevali and Altinay (2022), GHRM helps firms identify environmental trends. Thus, companies may reduce their environmental impact by employing green technology, practices, and certifications. Finally, green sustainable performance and green human resource management are interconnected and reflective. GHRM improves environmental consequences via many factors.

Sustainability and environmental performance improve corporate operations and provide long-term profitability and environmental protection. In polluted industries, GHRM is essential to improve environmental performance. We conclude that,

H1: GHRM has significantly influence green sustainable performance

Green sustainable performance as Mediator

In the interest of growth, multinational corporations put profit first over environmental protection. This expansion has a substantial negative impact on the businesses' operations, energy consumption, and efficiency. As a consequence of this gap, organizations have transitioned to renewable ways, reducing their environmental impact (Żywiołek et al., 2022). Organizations pursuing long-term success are particularly interested in investigating green process innovation within current advancements (Shahid et al., 2020).

According to Elzek et al. (2021), one of the most important ways to evaluate a company's sustainability performance is by looking at their green process innovation. This refers to the practice of creating processes that are good for the environment. The frequent release of pollutants is an integral part of the operations of many industrial organizations. The company has become more resilient to environmental challenges by using eco-friendly optimization strategies. According to Javaid et al. (2024), renewable energy sources including solar panels, wind turbines, and hydroelectric facilities may significantly enhance sustainability in this particular location. Businesses throughout the world are pouring money into renewable energy sources, such as solar panels, to meet the growing need for environmentally friendly power production (Uwaga & Emmanuel, 2024). GHRM has a stellar reputation in the business world because of its dedication to environmentally friendly procedures and green manufacturing. Utilizing green process innovation, GHRM aims for long-term success. Li et al. (2023b) states that companies are now teaching their workers green practices to reduce their impact on the environment. All of this is done to make the company more long-lasting. Businesses have a responsibility to priorities environmental efforts when they use sustainable human resource management strategies, such green training, according to Yafi et al. (2021), who concur with the NRBV concept. Renowned ecologists create an atmosphere that encourages staff members to think creatively.

This progress enables firms to influence sustainable performance via the adoption of green process innovation (Ahmeda et al., 2020). Singh et al. (2020) assert that GHRM significantly influences the sustainable performance and green innovation of organizations. Saptaria et al. (2022) assert that GHRM is a crucial element in the creative processes and performance of organizations. Altogether, the previous literature documenting GHRM, and green process innovation in the context of sustainable performance, state;

H2: Green process innovation significantly mediates the relationship between Green HRM and green sustainable performance.

Technological advancement as moderator

The situations are changing all over the world right now. Different groups are now stepping in to help make the tech easier to adopt since it's become more affordable. A bunch of sectors, like hospitality industries have jumped on the cause with cool tech tools like immense data and AI. Iqbal et al. (2023) mention that the global industrial scene is on the lookout for fresh innovations to boost the environment, and they've been using some pretty cool transformational tools to make it happen. Chen et al. (2023) point out that designing and planning new industrial infrastructure has always been viewed as a way to boost innovation. Making business processes better really

relies on how technology is advancing. For instance, artificial intelligence is being used in different industries to help companies keep an eye on and reduce energy consumption, plus make waste management better. Acter (2024) shows how tech has really stepped up to tackle environmental issues, from keeping biodiversity safe to managing energy, transportation, and farming. Look at sustainability for a sec; India has really made some progress lately. India's industrial sector has put a good amount of money into recycling and conservation technologies (Wagire & Kulkarni, 2024). These days, energy-efficient tech is where it's at for green innovation. The organization is stepping up its game in sustainable performance thanks to some cool tech advancements that are making green process innovation way more efficient (Dai & Zhu, 2024). Using eco-friendly tech lets businesses get creative and find ways to be sustainable for the long haul. Tech tools have totally changed the game in manufacturing, helping companies create and run processes while using less energy. In the global car scene, people really want cooler electric vehicles, which have led companies to work on using less energy. Boosting sustainable performance is all about creating renewable energy sources that cut down on gas emissions. Totally lessen the effects of all that waste piling up by using the new tech that helps the company stay eco-friendly (Kuppon et al., 2024). Research shows that green process innovation really boosts long-term sustainability because it's technically scalable. This study come to conclusion by building on the existing literature related to NBRV and institutional theory. Hence, we conclude:

H3: **Technological advancement moderates the relationship Green process innovation and green sustainable innovation.**

Conceptual framework

Figure 1 — Conceptual Framework

Source: This study model
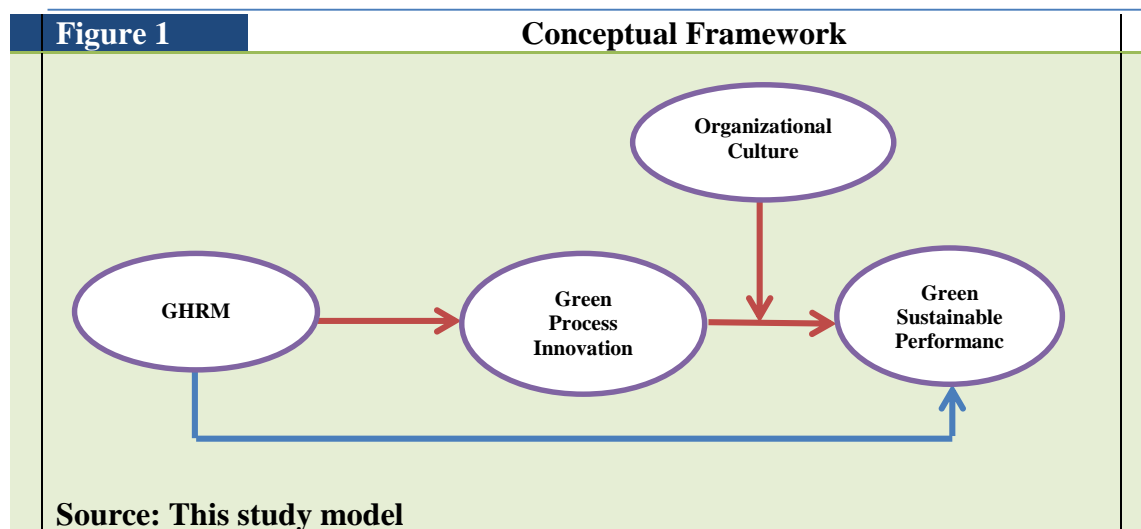
Methods

Study population and sample
The collection of data was accomplished through the utilization of a quantitative research technique; self-administered questionnaires were used. All of the variables were employed in the research study were derived from well-known and commonly used measures that were used in the past. According to Thomas et al. (2011), hospitality industries consist of establishments such as restaurants, hotels, and travel agencies that are owned and operated by their proprietors or independent managers and typically have fewer than fifty employees respectively. Utilizing a

survey questionnaire, the data for the research was collected from the individuals who were chosen to participate. It was decided to send out the questionnaire in three waves in order to get a satisfactory response rate. To individuals who were focus of the present study, a total of 830 questionnaires were sent. A response rate of 47% was achieved, with just 390 of them being returned complete throughout the survey. In comparison to other studies on hospitality industries that were conducted in the same field (Sobaih, 2020; Singh, 2020), the sample size of this study was found to be properly adequate. The profile of respondent composed of 390 individuals i.e., 200 from hotels and 190 from travel agencies. The sample size consists of 153 male participants, with a valid percentage 76.5% of the total. The majority of participants are male in both sectors, with 76.5% in hotels and in travel agencies are 77.4%. The respondents age shows most of the individuals are younger with valid percentage of 35% their ages were in between 18 and 28 years whereas travel agencies has a higher 38.9% in the age group between 29 and 38 years. Education levels suggest that a significant number of workers in both sectors have credentials below the SSC (34.0% in hotels and 34.2% in travel agencies), compared to HSSC holders, with higher education being less frequent. Employment status reveals that the majority of workers get daily wages (63.0% in hotels and 62.6% in travel agencies), indicating that they depend on temporary employment structures in the hospitality sector.

Table 1   **Demographic information**

Respondents profile		Hotels No & %	Travel agencies No & %
Gender	Male	153 (76.5%)	147 (77.4%)
	Female	47 (23.5%)	43 (22.6%)
Ages	18-28 years	41 (20.5%)	49 (25.8%)
	29-38	70 (35.0%)	73 (38.9%)
	39-48	57 (28.5%)	53 (27.9%)
	Above 48	32 (16.0%)	14 (7.4%)
Qualification	<SSC	68 (34.0%)	65 (34.2%)
	HSSC	59 (29.5%)	71 (37.4%)
	Bachelor degree	32 (16.0%)	23 (12.1%)
	Master degree	24 (12.0%)	19 (10.0%)
	>Masters	17 (8.5%)	12 (6.3%)
Employee status	Salary	74 (37.0%)	71 (37.4%)
	Daily wages	126 (63.0%)	119 (62.6%)
Total respondents		**200** (Hotels)	**190** (Travel agencies)
		n = 390	

Note: Coding scheme: {Gender ("1 for Male, 2 for Female")} {"{Ages"(<1 for 18-28, 2 for 29-28, 3 for 39-48, 4 for > 48")} {"{Qualification"(1 for <SSC, 2 for HSSC, 3 for Bachelor degree, 4 for master degree, 5 for > master degree")} {"{Employee status"(1 for salary, 2 for daily wages")}.

Measurement scale
A Likert scale with five points was used to analyze the responses of the participants. A score of one indicated a (strong disagree), while a score of five indicate a (strong agree). **(See table 2)**

Table 2 Scale These are the papers that were reviewed with the purpose of developing scale items.

Variables		Scale items	References
Independent variable	GHRM	**05**	(Sabokro et al., 2021)
Dependent variable	Green sustainable performance	**05**	(Gelhard and Von Delft, 2016)
Mediator	Green process innovation	**05**	(Xie et al., 2019)
Moderator	Technological advancement	**05**	(Chen et al., 2023)
	Total items	**20**	

Table 3 Scale reliability test

Sr.	Variables	Items	Alpha value
1	**GHRM (Independent variable)**	**05**	**.917**
2	**Green Sustainable Performance (Dependent variable)**	**05**	**.762**
3	**Green Process Innovation (Mediator)**	**05**	**.739**
4	**Technological Advancement (Moderator)**	**05**	**.883**

It is essential for the Cronbach's alpha to be greater than 0.70 in order to confirm the reliability of each component. Therefore, the values of all item Green human Resource management **(GHRM=.917),** Green Sustainable Performance **(GPI=.762),** Green Process Innovation **(GPI=.739),** Technological Advancement **(TA=.883)** are greater than 0.7, which indicates that the scale that was employed in this research is reliable. This conclusion is based on the data. **(See table 3)**

Table 4 KMO and BTS summary

	Independent variable GHRM	Dependent variable GSP	Mediator variable GPI	Moderator variable TA
KMO values	.890	.850	.787	.748
BTS values	Chi square (717.834)	Chi square (636.345)	Chi square (275.561)	Chi square (185.684)
P values	P =.000 (< .05)	P =.000 (< .05)	P =.000 (< .05)	P =.000 (< .05)

The requirements for sample adequacy are satisfied by the sample, as can be seen in the table that is displayed above. The KMO values are greater than 0.50, which corresponds with the conditions

that were discussed earlier. Thus, this makes it very clear that BTS values of the variables are appropriate; this study identified support for alternative hypotheses. **(See Tables 4)**

Hypotheses Testing

Table 5   **Coefficient summary of GHRM on GSP**

Path	Beta value	T value	P value	Decision
H1				
GHRM -> GSP	.616	12.82	.000	Supported

The hypothesis (GHRM->GSP) was evaluated with the use of SPSS version 24.0, which was utilized to perform regression analysis on the dataset. In accordance with the results, it has been shown that independent variable (GHRM) has positive and significant impact on the green sustainable performance (B =.616, t = 12.82, p =.000) Therefore, this finding provide acceptance to the H1 hypothesis. **(See table 5)**

Table 6   **Mediation analysis**

Paths	Estimates	Value of T	Value of p	ULLI -	ULCI
GHRM -> GPI	.4651	9.18	.000	.3653	.5650
GHRM -> GSP	.4917	8.80	.000	.3816	.6019
GPI -> GSP	.2675	3.97	.001	.1347	.4003
Total effect (TE)	.6162	12.82	.000	.5214	.7109
Direct effect (DE)	.4917	8.80	.000	.3816	.6019
Indirect effect (IE)	.1244		.000	.0520	.2174
Sobel test value			Z= 3.78		

This study examined green process innovation (GPI) as a mediator between green human resource (GHRM) and green sustainable performance (GSP). The finding of mediation analysis (Z=3.78, P=.000) illustrated that GPI partially mediated the association between GHRM and GSP. Hence, this study found support for H2. **(See table 6)**

Table 7   **Moderation analysis**

Path	Estimate	T	P	Decision
TA*GPI-> GSP	.2176	4.233	.000	Supported

Finally, investigation of the moderating influence of technical advancement (TA) on the link between green process innovation (GPI) and green sustainable performance (GSP) is shown in table. Based on findings, it can be concluded that the link between GPI and GSP is significantly moderated by TA, with a value of (B=.2176, P= 0.000). In light of this, hypothesis H3 is accepted.

Discussion

The study started with a review of the literature on the topic of green human resource management (GHRM) and how they influence green sustainable performance (GSP) of hospitality industries in Khyber Pakhtunkhwa, Pakistan. Based on the reviewed literature, a model was built and its validity and reliability were assessed. Present study found that green human resource management practice positively and significantly boosts green sustainable performance. Similarly, green process innovation partially mediates the relationship between GHRM practices and GSP. Furthermore, this study also found that technological advancement significantly moderates the association between GPI and GSP.Sarfraz et al. (2022) found that green human resource management is an important factor of sustainable performance for Pakistani organizations. Our analysis shows that these companies gain sustainable performance by using this strategy. Its development in the

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modern world guarantees the sustainable and environmental performance of the businesses, making it a crucial component for all organizations. The GHRM has a key influence on the environmental efficiency of the companies, revealed by Young et al. (2020). Additionally, it is geared towards a more environmentally friendly innovation system upon deployment (Cheema et al., 2020). Our study's main result is that the concept of GHRM fosters green process innovation, as shown by Khan et al. (2024). When compared to the previous research, the outcomes of the present study are consistent. H1 suggests that green HRM has positive influence on GSP. These results provide strong evidence in favor of our hypothesis, and we have also discovered a significant association between GHRM's impact on green sustainable performance.

However, our research that acknowledged the successful completion of green initiatives found that green process innovation helps to balance sustainability and environmental goals by standardizing green HRM (H2). By keeping these things in mind, businesses are better able to invest in environmentally friendly processes, technologies, and innovations which come under the NRBV's and institutional theory's umbrella. The company must adjust its goals to take into account environmental factors and innovation if it wants to be at the forefront of the sustainability movement. Green leadership enhances environmental performance by fostering a common goal of sustainability, which in turn elevates the value of green innovation (Saptaria et al., 2022). The link between green process innovation and environmental performance is strengthened when green leadership creates a supportive organizational culture, according to Khaddage-Soboh et al. (2024). After this, Han and Chen (2021) demonstrate that management now has access to a plethora of digital transformative tools that may help them achieve sustainable success via increased innovation in corporate processes. According to Dai and Zhu (2024), as technology advances, more and new creative methods are being used to boost long-term performance. Innovations in information technology (IT) that aim to protect society and the environment are considered a strategic innovation in green hospitality industries. As an example, India has made great strides in sustainability while having limited server resources. According to Waggire and Kulkarni (2024), India is pouring a lot of money into recycling and environmental protection technology. Problems arise in Pakistan due to the country's inadequate infrastructure and resources. Pakistan is falling behind India when it comes to environmentally friendly innovations, in contrast to India's growing IT industry and more severe economic rules. This suggests that Pakistani industries may need to start using more environmentally friendly procedures. Pakistan need a customized strategy to address the environmental issues, as is evident from examining these instances; if it wants to improve its environmental and sustainable performance. Pakistan may increase the impact of green technology practices in manufacturing by drawing on the experiences of emerging countries. As a whole, industrial economies have been seeing a surge in technical innovation. Its many uses have matured to the point that it greatly facilitates green process innovation in achieving long-term success (Yordanova, 2024). Consistent with prior research, our results demonstrate that technological advancements and resilient contribute to the success of green process innovation.

Practical implications

The current research on GHRM, green process innovation opens new routes to boots green sustainable performance. Hotels may greatly improve their environmental performance by adopting GHRM practices including green training, green recruiting, and green performance management. These actions may promote an environmentally conscious culture and inspire workers. Green process innovation could assist hotels diminish their effect on the environment and develop more environmentally friendly. There are a few ways in which hotels can utilize technology to enhance their environmental performance. Two examples of this are the usage of energy-efficient equipment and environmentally friendly components. It is possible to improve the

influence that great human resource management has on environmental performance by encouraging employee involvement and supporting green ideals. Hotels have the capacity to instill a feeling of ownership and responsibility in their staff members, which may ultimately result in greater sustainability results. GHRM may be incorporated into corporate strategy to enhance its impact on environmental performance. Hotels and travel agencies must align their GHRM practices with their environmental goals to establish a coherent sustainability the strategy.

Theoretical implications

Environmental performance has been widely acknowledged by researchers as an important factor. Many studies have shown ways that businesses might be more environmentally and sustainably responsible. Because of its uniqueness, this study has attracted the attention of scholars, researchers, and academic professionals all around the world. This study offers a rare chance to investigate that how hospitality industries are doing environmentally and sustainably in regard to green ideas. In order to understand the GHRM, GPI, TA, and GSP in Pakistan's hospitality industry, it provides a conceptual framework.

Future direction and Limitations

This study has few limitations that future researcher's necessity solves to achieve advantageous ecological consequences. This research was conducted in a restricted area of Khyber Pakhtunkhwa, Pakistan. As province of Khyber Pakhtunkhwa is not the only province influenced by environmental degradation, other province of Pakistan may also be examined this concern. Secondly, the research data was only gathered from the only hospitality industries in the province of KPK, Pakistan. This constraint renders our findings devoid of generalized outcomes. Therefore, to broaden the study's range, further research may be conducted in more sectors, including construction, pharmaceuticals, agriculture, transportation and, textiles, among others. Moreover, the research data was gathered by a questionnaire, which may not have prompted the participants to respond accurately. Consequently, it is recommended that future researchers use other analytical methodologies to investigate this conceptual model, such as soliciting open-ended responses from participants. Furthermore, the company's environmental performance should evaluate the principles of sustainable management practices. For further investigation, the study may include other factors to broaden the research area. The present study examined limited factors. Consequently, to address this gap, future research should include other green characteristics, including employee green trust, commitment, pro-environmental behavior, organization support, and as mediators and moderators. It offers an important framework including green innovation management. However, the research only examines the impact of green process innovation on the businesses' sustainability and environmental performance. Future study should pursue more accurate metrics to investigate the dynamics of the suggested green buildings.

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