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The nexus between green HR practices and firm sustainable performance in Saudi Arabia manufacturing industry: The role of green innovation and green transformation leadership

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ABSTRACT

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Environment concerns are now important for every business, especially manufacturing concerns due to imposing regulation regarding ecological performance. The quantitative study aims to investigate the impact of factors including green performance management and appraisal, green training and development and green compensation and reward on firm sustainable development of the manufacturing sector in Saudi Arabia. Furthermore, determine the mediating role of green innovation and green transformation leadership. Therefore, the role of these variables in causing actions of sustainability, through the purposive sampling we applied the administration of an online questionnaire to a sample of 350 employees of different levels from 40 manufacturing concerns. The study findings discovered that green human resource management practices positively influence firm sustainable performance. Additionally, the results indicated that green innovation and transformational leadership play an affirmative role in sustainable performance. Green innovation and transformational leadership partially mediate the link between green human resource management practices and firm sustainable performance. This study's findings provide a platform for policymakers and researchers in manufacturing firms to put green human resource-based approaches into practice to strengthen the employees' environmental commitment and enhance sustainable performance. On the other hand, this study has given a holistic vision of green human resource management practices, green innovation, transformational leaders, and sustainable performance. This research can be reflected as a rock on which other research projects will be built and provide empirical evidence regarding the connection.

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1. Introduction

Sustainable performance has attracted a lot of attention from businesses globally, which ultimately included environmental factors as an integral part of decision-making. Sustainability-based human resource management (GHRM) places importance on how HR decisions impact sustainable performance and the growth of firms. Besides contributing to preserving the environment, companies gain an advantage due to improved production efficiency and enhanced performance. The GHRM practices in connection with the sustainable firm performance of Saudi manufacturing are due to the Vision 2030 environmental setting in Saudi Arabia. Green HR practices recommend national policies to improve economic and environmental sustainable performance (Mousa & Othman, 2020). Saudi Arabia's focus on the significance of green HR practice as setting sustainability standards is one reason for using the organization's dominant regional position. The study aims to explore transformational leadership and Green Innovation (GI) so that top managers can understand how their businesses could enhance their efficiency regarding the environment. In this analysis, the concept of GHRM focuses on integrating business human resource practices with climate objectives and, in this way, is a significant part of the sustainable change process of a company (Saeed et al., 2019). Green Compensation and Rewards (GCR), Green Training and

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Development (GTD), and Green Performance Management and Appraisal (GPMA) are the components of GHRM practices. These approaches boost the businesses' eco-friendly power and overall sustainable performance.

The performance management and appraisal system are essential for firm sustainable performance. It increases the performance of an organization (Erialdy, 2024). Through implementation of a green compensation and reward system, employees are motivated to engage in sustainable practices, which lead to achievements of environmental goals (Das & Dash, 2024). Through this strategy, the organization can inspire its staff and demonstrate its tenacity in ecological care. While GI refers to the inventions of new goods, services, or techniques which cause less damage to the environment than the existing ones (Ogiewwonyi et al., 2023). Organizations can enhance their market position and gain a competitive advantage by placing emphasis on environmentally sustainable innovations (Hermundsdottir & Aspelund, 2022). Recent studies Sarfo et al., (2024) and Trujillo-Gallego et al., (2022) suggest that adopting GHRM practices could yield financial and environmental advantages for businesses. These practices contribute to the sustainability of enterprises.

Promoting transformation for sustainable leadership, where the GHRM practices are vital to the company's continued success, is a duty of environmentally conscious leadership (Perez et al., 2023). Ecological issues need to be integrated into the basics of HR to reach that objective; hence, GPMA, GTD, and green pay and awards techniques are used in the whole generation of GHRM approaches. When transformational leaders lead in environmentally friendly habits advocacy and practice them, the impacts of these efforts are taken to a whole new level (Luo et al., 2024). In line with the views of Singh et al., (2020), those executives are seen as the primary force behind the achievement of effectiveness by making work of proper implementation of companies' long-term strategies with sustainability goals. The integration of green transformational leadership in GHRM structures can increase workforce participation in sustainable practices and result in the formation of a culture of ceaseless innovation and development.

The present study does not only highlight the relationship between the sustainable performance of the business and GHRM, which targets both environment and the place of business, but it also contributes to broader understanding of the framework within which the latter are implemented. Firstly, our research introduces novelty to the Resource-Based View (RBV) as well as the Ability-Motivation-Opportunity (AMO) theories for the procedure affirming the extent to which green innovation (GI), GTL, and GHRM practices create and develop internal resources that, consequently, enhance a sustainable environmental performance via induced green processes in SMEs. The other fact is that the study suggests that the GI and the green transformational leadership all the time affect the firm's sustainable performance either directly or indirectly by implementing the GHRM practices. Through implementing these types of components, we prove that the relationship between leadership and innovation with HRM makes it possible for society to reach the best outcomes in respect to the environment. Finally, the study outputs practical insights of GHRM practices application that can boost environmental performance for most small companies and points out the functions of GI and sustainability leadership.

1.1 Research Questions

The present study's aims to address three critical research questions:

- What are the effects of GHRM on the sustainable performance of the manufacturing sector in Saudi Arabia?
- What is the role of GI for the implementation and the effectiveness of GHRM practices, to contribute to the sustainability of the manufacturing sector in Saudi Arabia?
- What is the role of green transformational leadership in the deployment and achievement of GHRM practices leading to enhanced sustainable performance manufacturing sector in Saudi Arabia?

The remainder of the paper is structured as follows: Section 2 provides the literature review, whereas Section 3 will describe the data and methodology used. Section 4 is devoted to the results and their comprehensive interpretation. Lastly, Section 5 provides the conclusion and outlines the policy implications of the findings.

2. Literature Review

The contribution of green HR policies to the sustainability of the performance of manufacturing companies in the Kingdom of Saudi Arabia could be intensified using RBV and AMO perspectives. Green practices, such as GPMA, green training and theories development, and green remuneration and recognition, are strategic assets that improve an organization's environmental, operational, and general performance (Barney, 1991). These approaches to businesses' eco-engineering innovation strategy promote a culture of constant improvement and environmental accountability by maintaining green profiles (Jabbour & Jabbour, 2016). Simultaneously, the AMO theory also underlines that the three fundamental forces regulating the success of an organization are the ability, motivation, and opportunities of the group of people, as argued (Boxall & Purcell, 2003). This green human resource management approach set in motion employee abilities to join the sustainability movement by providing opportunities for active participation in environmental activities, targeted sustainability training, and green incentives (Sarfo et al., 2024). Environmentally-focused innovations and eco-centric transformational

leadership make way for the equipping of green HR with even more firm foundations. GI creates environment-friendly products and technologies; the leaders who transform the organization towards the sustainability objective are green transformational leaders. Environmental and competitive success in the grand voting bloc can only occur if strategic human resource strategies are implemented (Mittal & Dhar, 2016; Renwick et al., 2013).

2.1 GPMA with Firm Sustainable Performance

GPMA is rapidly expanding, and with it comes the need to evaluate workers' efforts in an eco-friendly way that will undoubtedly contribute to companies' success in the long run. According to Ahmad et al., (2022), which demonstrated that green projects are improved when workers are involved in sustainability initiative Programmer's. Additionally, employing environmental policies in the performance management system significantly increases organizations' long-term effectiveness (Jamil et al., 2023). Renwick et al. (2023) also showed that organizations with recognized GPMA systems are more resource-efficient. Chen et al., (2023), revealed that environmental valuations positively affect staff members' assurance to sustaining the environment. Based on these findings, it becomes obvious that GPMA programs can be of significant value in improving organizations' overall performance and preserving competitive advantage over the long run.

Mousa and Othman (2020) specifies that supporting GPMA with GHRM approaches may support healthcare organizations in understanding sustainable performance. The findings reveal that the collaboration of environmental aspects, starting from the hiring process up to training, promotes the sustainability culture and its organizational performance. Ardiza et al., (2021) revealed that Green Performance Appraisal (GPA) and Green Compensation have an impact on environmental performances, which is ultimately related to the performance of workforces. Ecological workers can be created through GPA and green pay arrangements with performance dimension metrics and award activities(Mustafa et al., 2022). Enterprises can consider incorporating natural goals into their performance management systems and reward employees based on their participation in green practices (Marrucci et al., 2024). Furthermore, this strategy improves the workers' collective individual performance and intensifies levels of responsibility toward environmental protection and welfare.

H₁: *GPMA has a positive influence on firm sustainable performance.*

2.2 Green Training and Development with Firm Sustainable Performance

In light of the previous research, there is currently a lot of focus on the connections between green training and development; how they help companies achieve long-term sustainability. Sugiarti, (2021) demonstrated that well staff development and training Programmer's inform workers about environmental issues directly impacting productivity and work efficiency. The environmental performance of businesses with green training and development Programmer's increases, according to Ali et al., (2023), because workers in green jobs can identify and mitigate the effect of potential pollution on the environment. Furthermore, as indicated by Renwick et al. (2023), the green training and development achieves a mindset similar to one of constant creation and development of environment-friendly activities that use resources and waste less. Through coordination with their sustainability strategies, firms can use their training Programmers to enhance their environmental performance and attain a long-term competitive edge in increased productivity and superior corporate image. Green training and development is a way forward for sustainable performance in organizations, as indicated by Shoaib et al., (2022). The study concludes that GHRM will significantly benefit organizations with Programmer's focusing on the environment. These strategies boost organizational performance when companies commit themselves to green activities and motivate their workers through staff involvement and dedication to environmental objectives(Wang et al., 2023).

Zihan & Makhbul, (2024) confirms that training and career enhancement through GHRM are significant factors in achieving excellent organizational performance over the long term. Such techniques form the basis for green training and development, leading to human capital oriented toward environmental protection(Afzal & Rafiq, 2021; Khan et al., 2022). Enterprises can achieve sustainability goals by implementing educational programs that build workers' capacity to comprehend and correct environmental challenges as indicated by (AlKetbi & Rice, 2024). It will be achieved by positioning objectives in the economic, social, and environmental orientations. The empirical study of Faisal, (2023) shows that training and development contribute to developing GHRM initiatives as they provide a basis for creating an eco-friendly culture in the workplace. These actions can improve a company's overall environmental performance and help the staff become more aware of the company's sustainable goals.

H₂: *Green training and development has a positive influence on firm sustainable performance.*

2.3 Green Compensation and Reward with Firm Sustainable Performance

GHRM literature often highlights the importance of utilizing green as a motivation factor in organizational performance, mainly focusing on green pay and awards. Such environment-friendly reward and pay-out structures are designed to encourage employees to act sustainably in their workplace as indicated by Kuo et al., (2022). Besides, such incentives encourage workers to act in a way that suits the company's sustainability goals and provide the monetary incentive to fulfill such goals. The

findings from Khatoon et al., (2022) suggest a high association of employee efforts with the business's goals regarding environmental sustainability when a green remuneration scheme is used. Such Programmers' involve providing incentives to employees who complete their ecological objectives, like the goal of reducing waste or maximizing energy efficiency. Shahzad et al., (2023) explore the superseding effects of green innovation, green culture, and green workers' conduct in their research. Their study demonstrates that GHRM practices, which include eco-conscious compensation, generate long-term sustainability.

Mandago, (2018) demonstrates that green encouragement and pay programs are particularly effective in conclusive employees to perform in an environmentally friendly way. These approaches effectively bring into line self-interests with organizational sustainability concerns and motivating workers to pursue environmentally friendly aims. A study by Martins et al., (2021) shows that GHRM has a substantial role in the sustainability of organizations. Based on the findings, embracing an environmental HRM strategy can likely enhance the future adaptability of a company significantly. Thus, green hiring, green training, green performance appraisal, and green rewards and pay strategy are all apparatuses of this approach that associate to generating a concept of sustainability. Shahzad et al., (2023) investigate the possibility of green HR practices invigorating environmental protection. The study shows that shadowing GHRM practices, such as green pay and incentive schemes, might contribute to organizations reaching environmental sustainability.

H₃: *Green compensation and reward have a positive influence on firm sustainable performance.*

2.4 GHRM practices and Firm Sustainable Performance: Mediating Role of Green Innovation (GI)

GHRM has a positive impact on an organization's overall sustainability and performance with the mediation effect of green innovation (GI). Zihan & Makhbul, (2024) underscores that these approaches increased the sustainable performance with the help of green innovation and GHRM practices. GI strategies, such as environmentally friendly products or process improvements, may positively effect and achieve the sustainability objective of an organization (Zihan & Makhbul, 2024). According to Kanan et al., (2023), green products and innovation mediate between GHRM and sustainable performance. The GI process also focused on increasing environmental impact and inspiring economic growth by increasing operational efficiency. Awwad Al-Shammari et al., (2022) examines the potential mediating effect of GI on the relationship between sustainable performance and GHRM practices. The research findings indicate that implementing GHRM technology effectively enhances green performance and serves as a significant catalyst for green innovation. Additionally, the study shows that GI promotes sustainability and partly mediates the effects of GHRM on the environment. It shows the essence of HRM's incorporation of green approaches toward the development of sustainable human resource management programs into the strategies of the business. Kuo et al., (2022) revealed the effect of GHRM practices on environmental performance with the role of GI. The study highlights that green remuneration; performance management, training, and recruitment generate a green corporate culture that can drive innovation and sustainability in the organization.

H₄: *GI has a positive influence on GHRM.*

H₅: *GI plays a mediating role between GPMA and firm sustainable performance.*

H₆: *GI plays a mediating role between green training and development and firm sustainable performance.*

H₇: *GI plays a mediating role between Green compensation and reward and firm sustainable performance.*

2.5 GHRM practices and Firm Sustainable Performance: Mediating Role of Green Transformation Leadership

Recent studies emphasize that companies will achieve enhanced sustainable performance by incorporating Green Transformational Leadership (GTL) and Green Human Resource Management (GHRM). Studies on GHRM show that by including GTL, the GHRM activities can reduce the detrimental environmental impact and help workers by inspiring them to use an ecological way of living. Perez et al., (2023) explored how production efficiency can be enhanced by GTL technology integrated with GHRM policies. Interactions among the firms directly improve their environmental performance, which in return boosts the motivation of each worker to practice among the firms. Younis & Hussain, (2023) reaffirms that the GTL can be an invaluable tool in reaching sustainable performance in the three key areas of economics, society, and the environment. Alongside enabling green initiatives, the governing model of leadership transformations mediates the link between GHRM practices and sustainable performance. The study findings indicate that management and leadership styles that support those innovations are crucial. Awan et al., (2023) explore the role of GHRM, GTL, and GI in changing firms' environmental performance. The study revealed that GI and GTL could improve sustainable performance through GHRM practices. In line with this study, Hameed et al., (2022) explored the connections between GHRM, green transformational leadership, and perceived organizational support. By acting as an intermediary, green transformational leadership increases the impact of green HRM practices on the perception of organizational support for sustainability and performance. Moreover, transformational leadership is essential for environmental performance enhancement and promoting sustainable organizational culture (Niazi et al., 2023). The present study revealed that these GTL induce green behaviors and creative ideas in the workplace, which leads to higher sustainable performance.

H₈: *Green transformational leadership has a positive influence on GHRM.*

H₉: *Green Transformation Leadership plays a mediating role between GPMA and firm sustainable performance.*

H₁₀: *Green Transformation Leadership plays a mediating role between green training and development and firm sustainable performance*

H₁₁: *Green Transformation Leadership plays a mediating role between Green compensation and reward and firm sustainable performance*

2.6 Conceptual Framework and Hypothesis Development

The conceptual framework supports an empirical investigation of the proposed connections within the model, which is shown in Fig. 1.

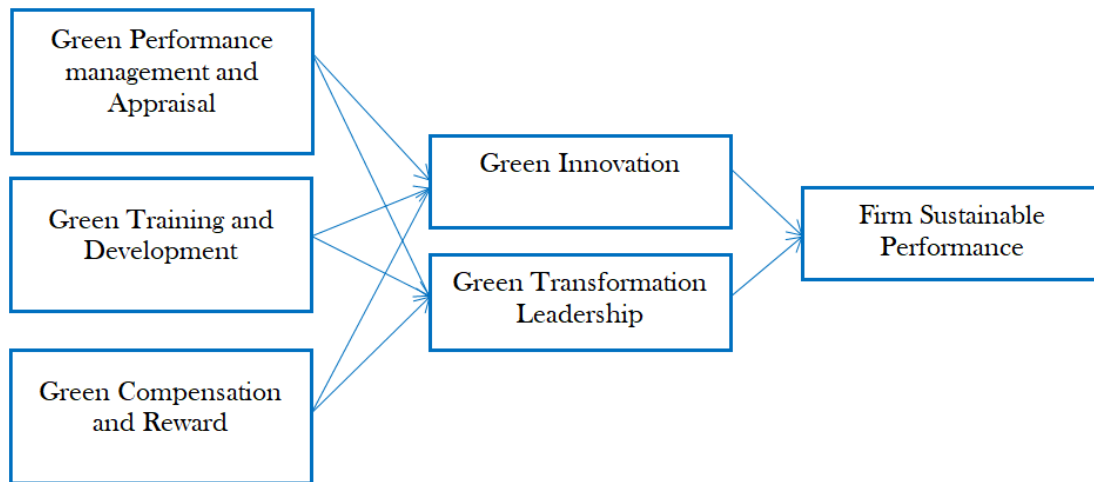


Fig. 1. Conceptual framework

3. Research Methodology

The quantitative study aims to investigate the impact of factors including GPMA, green training and development and green compensation and reward on firm sustainable development of the manufacturing sector in Saudi Arabia. Furthermore, determine the mediating role of green innovation and green transformation leadership. Environment concerns are now important for every business, especially manufacturing concerns due to imposing regulation regarding ecological performance. The GPMA, green training and development and green compensation and reward were employed in quantitative research to investigate how to contribute to the sustainable performance of the manufacturing sector in Saudi Arabia. Therefore, the present study employed a purposive sampling technique. Regarding the role of these variables in causing actions of sustainability, through the purposive sampling we applied the administration of an online questionnaire to a sample of 350 employees of different levels from 40 manufacturing concerns. The population of the present study is the total number of manufacturing companies in Saudi Arabia. Therefore, the present study was chosen from 40 manufacturing companies randomly using criteria that guaranteed their answers would be relevant to the study.

3.1 Measurement of Scales

This investigation utilized scales that had achieved maturity beforehand. A two-part questionnaire was produced as part of the research. We requested personal information from respondents in the initial segment of the survey. 36 questions regarding the independent and dependent variables of the study contained the second segment of the survey, which was designed to measure responses to the proposed model. 1 point shows strongly disagree, and 5 points specifies strongly agree, on a five-point Likert scale employed in the study. The following sources provided the details for this: GPMA, Green training and development, and Green compensation and reward were evaluated by 5 items each getting from Saeed et al., (2019). GI was measured with 5 items extracted from Chen et al., (2006). Green transformation leadership was assessed with the scale of (Singh et al., 2020). Finally, firm sustainable performance was measured using 5 items from the study (Mousa & Othman, 2020).

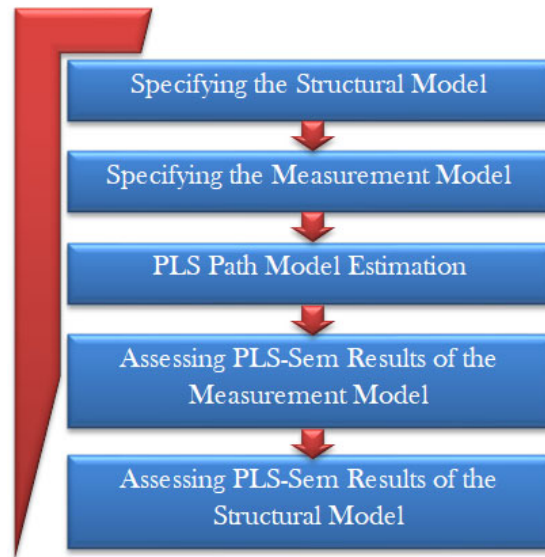
Table 1

Summary of questionnaire

Variable	Abbrev.	Items
Green performance management and appraisal	GPMA	5
Green training and development	GTD	5
Green compensation and reward	GCR	5
Green innovation	GI	5
Green transformation leadership	GTL	5
Firm Sustainable Performance	FSP	5

3.2 Data Analysis Procedure

The present study used Smart (PLS 4.0), a well-known application for PLS-SEM (Hair et al., 2017; Henseler et al., 2015), a technique for evaluating structural equations, to analyze the data for this investigation. Sarstedt et al. (2014) state that PLS-SEM permits the incorporation of intricate model attributes, thereby granting increased adaptability in the process of analysis and interpretation. Fig. 2 presents the procedure analysis using Smart-PLS.

**Fig. 2.** PLS-SEM Procedure

4. Results and Findings

4.1 Demographics and Descriptive Statistics

Table 2 shows details about all of the respondents' data.

Table 2

Respondent data

Variable	Frequency	Percentage	Variable	Frequency	Percentage		
Gender	Male	238	68%	Education	Bachelor	151	43.14%
	Female				Master	96	27.43%
			M.Phil.		80	22.86%	
			PhD.		23	6.57%	
Age	21-30	80	22.86%	Management level	High Level	127	36.29%
	31-40	141	40.29%		Medium Level	98	28.00%
	41-50	50	14.29%		Low Level	67	19.14%
	51-60	79	22.57%		Other	68	19.43%

4.2 Convergent Reliability and Validity

Table 3 demonstrates the findings of convergent validity and reliability. The purpose of conducting a convergent validity and reliability analysis is to determine the reliability and validity of the items comprising the research scale. The investigators established convergent validity using the PLS method. In their respective studies, Hair et al., (2007) and Henseler et al., (2014)

stipulate minimum values of 0.60 for factor loadings, 0.70 for “Cronbach's alpha, composite reliability, and average variance extracted”. Cronbach's alpha values exceeding 0.80 are present for all variables listed in Table 3. Each of the examined structures exhibited factor loadings that exceeded 0.60. The critical (CR) and average (AVE) values of these variables exceed 0.50. Hence, the present investigation demonstrates convergent validity and reliability. Table 3 presents the VIF values, which indicate that this research model does not exhibit any multicollinearity issues. Therefore, each VIF value is below 5.

Table 3
Results of Convergent Reliability and Validity

Constructs	Items	Factor Loading	CA	CR	AVE	VIF
GPMA	GPMA1	0.792	0.817	0.841	0.587	1.951
	GPMA2	0.802				2.43
	GPMA3	0.861				2.81
	GPMA4	0.532				1.272
	GPMA5	0.802				2.017
GTD	GTD1	0.692	0.734	0.735	0.556	1.433
	GTD2	0.733				1.893
	GTD3	0.629				1.255
	GTD4	0.748				2.165
	GTD5	0.677				1.58
GCR	GCR1	0.778	0.877	0.908	0.635	2.576
	GCR2	0.842				3.141
	GCR3	0.823				2.837
	GCR4	0.759				1.225
	GCR5	0.901				2.442
	GCR6	0.894				2.561
GI	GI1	0.555	0.879	0.905	0.687	1.251
	GI2	0.886				3.704
	GI3	0.901				3.115
	GI4	0.873				3.419
	GI5	0.878				3.488
GTL	GTL1	0.895	0.94	0.941	0.806	1.251
	GTL2	0.912				3.704
	GTL3	0.889				3.115
	GTL4	0.868				3.419
	GTL5	0.923				3.327
FSP	FSP1	0.832	0.878	0.907	0.643	2.566
	FSP2	0.738				1.34
	FSP3	0.870				3.331
	FSP4	0.933				1.085
	FSP5	0.874				3.109
	FSP6	0.765				1.842
Average Value of VIF						2.529

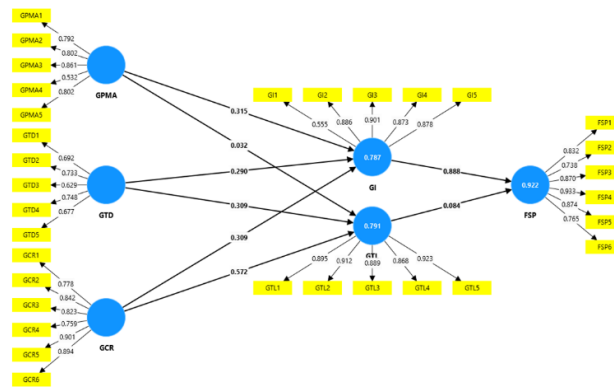


Fig. 3. Measurement of Model

4.3 Discriminant Validity

The basic objective of the present study is to determine the causal association among the variables. Therefore, to assess the discriminant validity of the research, we employed the HTMT, Fornell Larker criterion, and cross-loading methodologies proposed by Hair Jr. et al. (2017).

Heterotrait-Monotrait Ratio (HTMT)

Gold et al., (2001) used the HTMT method to determine the study's discriminant validity. As stated by Gold et al., (2001) HTMT values should not exceed 0.90. Table 4 illustrates that scale items with values below 0.90 have a low degree of discriminant validity. We test the hypothesis using scales that empirically demonstrate discriminant validity.

Table 4
Results of HTMT

	FSP	GCR	GI	GPMA	GTD	GTL
FSP						
GCR	0.834					
GI	0.892	0.756				
GPMA	0.756	0.895	0.767			
GTD	0.791	0.809	0.698	0.819		
GTL	0.815	0.749	0.724	0.766	0.781	

4.4 Fornell-Larcker Criterion

Moreover, to determine the robustness of the measurement model, the present study examines the discriminant validity of the constructs. Table 5 displays the results from the Fornell-Larcker criterion assessment of the structures. The findings indicate that the constructs satisfy the requirements for discriminant validity.

Table 5
Results of Fornell-Larcker Criterion

	FSP	GCR	GI	GPMA	GTD	GTL
FSP	0.802					
GCR	0.847	0.797				
GI	0.759	0.867	0.729			
GPMA	0.816	0.752	0.769	0.766		
GTD	0.788	0.793	0.849	0.899	0.697	
GTL	0.836	0.778	0.847	0.854	0.848	0.798

4.5 Cross Loading

Furthermore, Table 6 presents the construct's cross-loading analysis results. Therefore, the findings demonstrate a rigorous validation of the constituents that comprise the construct scale of the research model.

Table 6
Results of Cross Loading

	FSP	GCR	GI	GPMA	GTD	GTL
FSP1	0.832	0.886	0.805	0.850	0.832	0.857
FSP2	0.738	0.299	0.444	0.316	0.493	0.370
FSP3	0.870	0.645	0.802	0.589	0.561	0.640
FSP4	0.933	0.753	0.901	0.698	0.664	0.739
FSP5	0.874	0.709	0.787	0.667	0.627	0.675
FSP6	0.765	0.664	0.790	0.708	0.603	0.660
GCR1	0.733	0.778	0.784	0.789	0.618	0.575
GCR2	0.769	0.842	0.801	0.854	0.756	0.765
GCR3	0.687	0.823	0.710	0.813	0.849	0.895
GCR4	0.281	0.759	0.279	0.382	0.374	0.357
GCR5	0.718	0.901	0.713	0.805	0.786	0.742
GCR6	0.729	0.894	0.719	0.793	0.775	0.735
GI1	0.523	0.413	0.555	0.422	0.587	0.426
GI2	0.847	0.831	0.886	0.815	0.821	0.717
GI3	0.933	0.753	0.901	0.698	0.664	0.739
GI4	0.809	0.752	0.873	0.789	0.698	0.795
GI5	0.805	0.770	0.878	0.811	0.744	0.776
GPMA1	0.635	0.789	0.679	0.792	0.738	0.640
GPMA2	0.573	0.783	0.617	0.802	0.737	0.777
GPMA3	0.751	0.862	0.793	0.861	0.797	0.759
GPMA4	0.478	0.425	0.503	0.532	0.418	0.432
GPMA5	0.662	0.716	0.709	0.802	0.696	0.611
GTD1	0.623	0.654	0.685	0.724	0.692	0.602
GTD2	0.475	0.721	0.501	0.677	0.733	0.666
GTD3	0.607	0.410	0.614	0.427	0.629	0.473
GTD4	0.429	0.670	0.476	0.620	0.748	0.626
GTD5	0.594	0.638	0.658	0.656	0.677	0.579
GTL1	0.687	0.823	0.710	0.813	0.849	0.895
GTL2	0.775	0.789	0.786	0.735	0.704	0.912
GTL3	0.828	0.755	0.814	0.709	0.746	0.889
GTL4	0.674	0.742	0.680	0.741	0.698	0.868
GTL5	0.781	0.829	0.803	0.832	0.806	0.923

4.5 Direct Relationship

The results relating to the direct path as determined by the SEM model are presented in Table 7. GPMA has a significant impact on the sustainable performance of the manufacturing sector in Saudi Arabia. Based on the obtained results (coefficient = 0.315, t-value = 2.271, and p-value < 0.05), it can be concluded that the first hypothesis is accepted at a significance level of 5%. The present study's findings are consistent with those of previous research (Kuo et al., 2022). Furthermore, green training and development have a significant impact on Saudi Arabia's manufacturing sector's sustainable performance. The results (coefficient = 0.283, t-value = 2.938, and p-value < 0.05) support the acceptance of the second hypothesis at the 5% significance level, and the present study's conclusions are consistent with prior investigation (Sarfo et al., 2024). Moreover, green compensation and rewards have a significant impact on Saudi Arabia's manufacturing sector's sustainable performance. The third hypothesis has been accepted at the 5% level of significance based on the results (coefficient = 0.322, t-value = 2.464, and p-value < 0.05). The current study's findings are in line with earlier research (Martins et al., 2021).

Table 7
Results of Direct Relationship

Direct Relationship	Coefficient	Std. Dev.	T statistics	P values	Remarks
GPMA → GI	0.315	0.139	2.271	0.023	Supported
GTD → FSP	0.283	0.096	2.938	0.003	Supported
GCR → FSP	0.322	0.131	2.464	0.014	Supported

4.6 Indirect Path/Mediation Effect

Table 8 demonstrates the results of indirect relationship, which was determined by using PLS-SEM. There is a significant mediating effect of GI in the relationship between GPMA and firm sustainable performance of the manufacturing sector in Saudi Arabia. Therefore, according to results (coefficient = 0.279, t-value = 2.372, and < 0.05), the fourth hypothesis has been accepted at 5% significance level. Furthermore, there is a significant mediating effect of GI in the relationship between green training and development and firm sustainable performance of the manufacturing sector in Saudi Arabia. Therefore, according to results (coefficient = 0.257, t-value = 2.608, and < 0.05), the fourth hypothesis has been accepted at 5% significance level. Moreover, there is a significant mediating effect of GI in the relationship between green compensation and reward and firm sustainable performance of the manufacturing sector in Saudi Arabia. Therefore, according to results (coefficient = 0.374, t-value = 2.652, and < 0.05), the fourth hypothesis has been accepted at 5% significance level. Furthermore, the analysis reveals that there is an insignificant mediating role of green transformation leadership in the association between GPMA and the sustainable performance of manufacturing firms in Saudi Arabia. According to the results (coefficient = 0.003, t-value = 0.868, and p-value > 0.05), the eighth hypothesis has been rejected. Moreover, results reveal that green transformation leadership mediates the relationship between green training and development and the sustainable performance of manufacturing firms in Saudi Arabia. Based on the obtained results (coefficient = 0.056, t-value = 2.545, and < 0.05), the findings indicate that the fourth hypothesis is accepted at a significance level of 5%. Lastly, green transformation leadership mediates the relationship between green compensation and reward and the sustainable performance of Saudi Arabia manufacturing firms. Based on the obtained results (coefficient = 0.008, t-value = 3.636, and < 0.01), the findings indicate that the fourth hypothesis is accepted at a significance level of 1%.

Table 8
Results of Indirect Relationship/Mediation Effect

Indirect Relationship	Coefficient	Std. Dev.	T statistics	P values	Remarks
GPMA → GI → FSP	0.279	0.118	2.372	0.018	Accepted
GTD → GI → FSP	0.257	0.099	2.608	0.009	Accepted
GCR → GI → FSP	0.374	0.141	2.652	0.032	Accepted
GPMA → GTL → FSP	0.003	0.016	0.188	0.868	Rejected
GTD → GTL → FSP	0.056	0.022	2.545	0.037	Accepted
GCR → GTL → FSP	0.800	0.220	3.636	0.006	Accepted

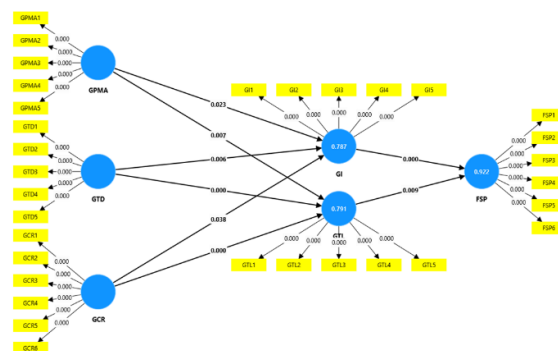


Fig. 4. Structural Equation Modeling

5. Discussion

There is a significant impact of green management performance and appraisal on firm sustainable performance of the manufacturing sector in Saudi Arabia. Thus, according to results, the first hypothesis has been accepted at a 5% significance level (Kuo et al., 2022). GPMA contributes to the sustainable competitive performance of firms in Saudi Arabia's manufacturing sector. It promotes environmental efficiency, helps with compliance, improves the company's financial performance, supports a competitive edge, aids in the development of market relationships, helps improve operational resilience, encourages social responsibility, and fosters innovation (Khan et al., 2019). GPMA also helps companies become environmentally compliant, manage risks, appeal to investors, improve brand positioning, position products and services to capture the attention of consumers, and encourage the environmental impact of products and processes on suppliers.

Furthermore, there is a significant impact of green training and development on the firm sustainable performance of the manufacturing sector in Saudi Arabia. Thus, according to results, the second hypothesis has been accepted at 5% level of significance (Sarfó et al., 2024). The effectiveness of green training and development in Saudi Arabia is empirically evaluated in relation to the sustainability performance of manufacturing firms. It creates value for a firm by enhancing resource productivity, reducing pollution and waste as a way of meeting regulations, cutting operations costs, and even bringing in investments, among other benefits. An organization can apply the green training and development in other areas to manage supply chain sustainability and socially responsible processes. It also ensures that the products adhere to quality standards and continues to improve through feedback and competition, which in turn leads to improvements in the manufacturing sector's sustainability.

In addition, there is a significant impact of green compensation and reward on the firm sustainable performance of the manufacturing sector in Saudi Arabia. Thus, according to results, the third hypothesis has been accepted at 5% level of significance (Martins et al., 2021). In the Saudi Arabia manufacturing industry, green organizational context plays a moderating role in sustainability, rewards, and compensation. Social responsibility makes such companies advocate for sustainable practices, their influence in innovation, inspiring employees, transforming the company culture, improving operations, increasing stakeholder relations, conforming to regulations, and achieving sustainability. These systems focus on promoting the employees' sustainable behaviors, supporting new ideas, and increasing efficiency. Furthermore, green compensation and reward systems lead to sustainability and resilience in the manufacturing industry.

There is a significant mediating effect of GI in the relationship between GPMA and firm sustainable performance of the manufacturing sector in Saudi Arabia. Therefore, according to the result, the fourth hypothesis has been accepted at 5% significance level. They influence change, encourage sustainable behavior, encourage innovation, boost employee engagement, contribute to ethical and cultural change, improve efficiency and effectiveness, increase stakeholder relationship and compliance, and contribute sustainability. These systems encourage employees to engage in sustainable activities; increase productivity and innovation, and other efficiency gains. It also reduces the establishment of a culture of sustainability; a culture whereby various entities embrace ecological responsibility. Taken as a whole, green compensation and reward mechanisms benefit the manufacturing industries towards a more sustainable way of doing business.

Furthermore, there is a significant mediating effect of GI in the relationship between green training and development and firm sustainable performance of the manufacturing sector in Saudi Arabia. Therefore, according to results, the fifth hypothesis has been accepted at 5% significance level. Therefore, training and development should be structured on the basis of green innovation. It makes employees more proactive in making suggestions on sustainability and managing sustainability thrust that creates greater efficiency and effectiveness and competitive advantage. Sustainable performance is also enhanced by GI as the former helps to achieve positive performance outcomes in the long run such as cost reduction, increased company's reputation, and endorsement from stakeholders. Mediation of green innovation enables a dynamic positive cycle where the dissemination of successful initiatives facilitates further sustainability innovation which leads to more opportunities for improvement.

Moreover, there is a significant mediating effect of green innovation in the relationship between green compensation and reward and firm sustainable performance of the manufacturing sector in Saudi Arabia. Therefore, according to results, the sixth hypothesis has been accepted at 5% significance level. Therefore, the mediating role of GI enhances the relationship between green compensation and reward and firm sustainable performance. For that green compensation and reward constantly inspire to develop new greening solutions and to employ their knowledge to make companies' environmentally more effective, efficient and competitive. Green innovativeness results in effective mediation that forms a cycle of improvement whereby the innovation of GCRs leads to the development of further sustainability initiatives. Employees will also be encouraged to achieve more with their green ideas and this leads to more opportunities for improving sustainable performance.

Additionally, the relationship between GPMA and the sustainable performance of the manufacturing sector in Saudi Arabia is not significantly mediated by green transformation leadership. Consequently, the results indicate the rejection of the eighth hypothesis. Furthermore, in Saudi Arabia, green transformation leadership has a significant mediating effect on the relationship between green training and development and the sustainable performance of the manufacturing sector. The results

confirm the acceptance of the ninth hypothesis at the 5% significance level. A green transformational leadership style is a form of leadership that improves sustainability within organizations. It contains resources to leaders to sustain sustainability programs and gratifying them accordingly. Green training and development adopts a leadership environment that pushes sustainable change. It assists as a mediator between green training and development and the sustainable performance of the firm. It strengthens the connection between green training and development and sustainable firm performance, thus increasing the point and the time prospect of the impact that green training and development have on a firm's efficiency, efficacy, and effectiveness in the environment.

Finally, in Saudi Arabia, green transformation leadership has a significant mediating effect on the connection between green compensation and reward and the sustainable performance of the manufacturing sector. Subsequently, the results confirm the acceptance of the tenth hypothesis at the 1% significance level. The mediating role of green transformational leadership increases the relationship between green compensation and reward and firm sustainability. This results in improved use of natural resources as well as higher performance and competitiveness. Green compensation and rewards also set sustainable change in motion because successful initiatives can create more leadership opportunities. We encourage leaders to uphold the sustainability agenda, thereby generating additional opportunities to enhance the performance of green compensation and reward, promote sustainability, and highlight the positive outcomes of sustainability initiatives. This consequently brings about longer-term returns such as greater costs, an improved image, and even better stakeholder relations.

6. Conclusion

The study investigates the impact of factors such as green performance, management, training, development, and compensation on Saudi Arabia's manufacturing sector's sustainable development. It also explores the mediating role of GI and green transformational leadership. The research uses purposive sampling to examine the role of these variables in promoting sustainability. The present study has administered an online questionnaire to 350 employees from 40 manufacturing companies in Saudi Arabia, ensuring the study's relevance. The study aims to understand how these factors contribute to Saudi Arabia's manufacturing sector's sustainable performance. The study highlights the importance of environmental concerns in business, particularly in the manufacturing sector. The study reveals that green performance, management and appraisal, green training and development, and green compensation and reward have a significant impact on Saudi Arabia's manufacturing sector's sustainable development. Furthermore, in the Saudi manufacturing sector, GI and green transformation leadership play an important mediating role. The present study has accepted the first, second, third, fourth, fifth, sixth, seventh, ninth, and tenth hypotheses at 5% and 1% significance levels. Therefore, the eighth hypothesis has been rejected.

6.1 Policy Implications and Future Directions

The importance of green management practices has been identified to affect the sustainable performance of Saudi Arabia manufacturing companies; the following policy implications and research directions can be derived from this study. Firstly, governments have to introduce GPMA policies, for instance, in the form of tax incentives or legislation that fosters sustainability. Secondly, for these practices to be more effective, they should be conducted within the general framework of national sustainability standards. Moreover, making sure that corporate green practices have real consequences is possible by applying accountability and transparency constraints. Thirdly, GI could be supported through funding for green technology research and development. Lastly, sustainable development-oriented initiatives should be promoted, particularly that leadership makes a difference. Further research could also involve following up on such programs longitudinally to ascertain their effects in the long run and obtain results from other industries or other countries to get a broader view of how effective such practices are. Further understanding of how to enhance green management practices and outcomes may be derived from more research on these strategies' impact on the value chain as well as the integration of modern technology.

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