How Green Transformational Leadership and Green Entrepreneurial Orientation Contribute to Firm Sustainable Performance: The Role of Green Innovation and Environmental Concerns

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Abstract

The prime aim of the quantitative study is to explore the impact of green transformational leadership and green entrepreneurship orientation on firm sustainable performance within the manufacturing sector of Saudi Arabia. In addition, the current research also examined the moderating effect of environmental concerns and the mediating impact of green innovation. For analysis, the current study adopted PLS-EM. From the findings, green transformational leadership and green entrepreneurship orientation significantly impact green innovation, leading to a sustainable firm's performance in the Saudi Arabia manufacturing industry. The same is statistically significant in enlightening the firm's sustainable performance. Green innovation has played a substantial role in mediating the impact of the correlation among transformational leadership and green entrepreneurship on firm sustainable performance. The present research further extends evidence showing that environmental concern has significantly moderated the relationship among green entrepreneurship orientation, green transformational leadership and firm sustainable performance. The findings provide implications for progress in the sustainable performance of manufacturing firms, specifically in Saudi Arabia. Hence, the emerging green transformational leadership and entrepreneurial orientation are integrating environmental concerns in firm governance and establishing promising strategies to enhance the manufacturing industry's sustainable performance in Saudi Arabia.

Keywords: Green entrepreneurship orientation, green innovation, Green transformational leadership , environmental concern, firm sustainable performance.

In the last decade, the research focus has been shift in the human resource management (HRM) with regard to organizations sustainable environment perspective (Ahmad et al., 2024). According to the researchers (Awan et al., 2023; Q. Zhang et al., 2024; Zihan et al., 2024), manufacturing companies and organizations should adopt green policies that enhance management performance and efficiency to attain a highly competitive advantage and sustainable performance. Green transformational leadership (GTL) and pro-environmental workstation behaviors can increase the employee's understanding of environmental protection values (Alberto et al., 2023). Green Transformational Leadership (GTL) combines

transformational and environmental leadership features, stressing that leaders should influence and mobilize subordinates towards top organizational performance in environmental management (Qalam & Keagamaan, 2024). GTL involves leaders who can communicate the sustainability vision in their organizations, champion creativity on ecological issues, and promote an environment-friendly culture within the organizational structure. This leadership approach is essential in fostering green innovation because people are not just told how and when to be green at the workplace but have to look for ways of going green (Iqbal et al., 2021). Some studies have revealed that GTL uniquely affects a firm's performance by fostering green organizational identity and innovation that culminates in sustainable performance (Qalati et al., 2023). The successful case studies of GTL application in the manufacturing and tourism industries prove the efficiency of these solutions on both environmental and organizational aspects (Huong et al., 2021). Thus, with the implementation of GTL in organizational systems, organizations will manage to bring strategies into compliance with environmental factors, enhancing competitiveness to meet the expanding market demand for green practices (Xue & Boadu, 2019).

Similarly, Organizations prioritize sustainability and stability to ensure survival, resulting in a rise in green entrepreneurship (Jiang et al., 2018). Green strategies provide organizations with an opportunity to respond to stakeholder demands and enhance environmental and organizational performance (Y. Chen et al. 2014). Green Entrepreneurial Orientation entails strengthen an organization's environmental, financial, and social performance. It integrates the concepts of corporate initiative, competitive aggression, and environmental consciousness. Green entrepreneurial firms improve their overall environmental performance through product and service innovation, employee health and safety promotion, and consumer rights enhancement. They also improve the financial performance through resource cost, which responds to the product development processes, being innovative in the first moment in the industry, and generating non-recurrent gains with important and original investments in sustainable projects (Momayez et al., 2023).

Furthermore, green innovation encompasses both green and non-green technological innovations, all aimed at enhancing environmental sustainability (Hameed et al., 2023). Every green innovation is a method that aids the growth of sustainable development by minimizing the amount of pollution, energy use, and waste production. Moreover, we categorize it into green product and process innovation, both of which strive to reduce negative environmental effects (Sun et al., 2022). New product development for environmental improvement entails the formation of products that are environmental friendly and/or services, whereas new process innovation employs environmental friendly technologies and the processes (Doghan et al., 2022). However, a number of barriers, including technical know-how and limited resources, challenge the decision to implement green innovation (Majali et al., 2022). Hence, green innovation can serve as a solution to both economic growth and environmental protection for MSMEs (D. Green et al., 2022). As climate change issues arise and with adaptation to the identification of the impact of business-related environmental issues, there has been a move towards increased business organization environmental sustainability (Singh et al., 2022). Economically, ecological interests prompt corporations to implement sustainable strategies, integrate environmental technologies, and comply with regulations and consumers' demands. They also affect consumers, investors, and other stakeholders, forcing firms to alter their actions and become more sustainable (Sweeney et al., 2018). In the case of entrepreneurial orientation, green transformational leadership and, the

environment is a moderator since it strengthens the firm's sustainable performance results (Sangadji & Islami, 2024). Business organizations with an environmentalist philosophy have higher sustainable performance because environmentalism is a strategic priority in an organization's model (Le et al., 2024). Implementing policies by governments and international agencies to promote sustainable practices has increased awareness of eco-innovations (Science et al., 2022). Eco-innovation is also a term for strategies applied within organizations that support environmental change, advance environmentally friendly products and engineer progressive ecological alterations. These innovations generate a competitive edge and attract state funding and incentives by facilitating economic savings, promoting a circular economy, and aligning with consumer interests (Iqbal et al., 2021). Implementing eco-friendly practices is contingent upon the involvement of employees, who are instrumental in comprehending organizational practices and promoting sustainability initiatives (Asad et al., 2021). Hence, this research examines GTL and GEO's impact on the firm's sustainable performance (FSP). It also examines the mediation role between GTL, GEO, and FSP. The study also analyzed the moderating effect of environmental concerns among Green Innovation (GI), GTL, and GEO. The study provides valuable insight for policymakers and high-level management to enhance firm sustainable performance.

Objectives

The main objectives of present research are as follows:

- To assess the influence of GTL and GEO on the firm sustainable performance (FSP) in Saudi Arabia manufacturing sector.
- To assess the mediation role of green innovation between GTL, GEO and FSP in Saudi Arabia manufacturing sector.
- To assess the moderating impact of environmental concerns between GTL, GEO and FSP in Saudi Arabia manufacturing sector.

Literature Review

Green Transformational Leadership and Green Innovation and Firm Sustainable Performance

Green transformational leadership is a concept that combines transformational leadership and environmental conservation. It has the ability to motivate subordinates to go beyond the expected levels of environmental performance (Adebloom et al., 2019; Kumar et al., 2020). Al-Romeedy and El-Sisi (2024) discovered that green transformational leadership has a positive impact on the performance of tourism and hospitality industries. The investigation showed that green organizational identity had a large impact on GI and FSP. Moreover, outcomes revealed that GI moderate the relationship between GTL and FSP. The research enhanced the theoretical understanding of GTL and presented solutions to managers to increase green innovation and performance. Chen et al. (2023) examined the moderating role concerning the association between GTL and GI in mega-projects. The results show that GTL has an effect on both green product innovation (GPDI) and green process innovation (GPCI). This effect is partly passed on to GI through the green knowledge stock (GKS). Furthermore, reports indicate that the innovation climate provides a significant positive moderating effect.

Likewise, Green et al. (2023) demonstrated the influence of green transformational leadership on green innovation (GI) in chemical organizations. The research hypotheses of this study, established that green TLP influences IGIA through CPE and GC as moderating sub processes. Sonino (2023), in a study on the relationship between green transformational leadership and green innovation, noted that the generation of green innovation requires a green culture. Seven of them suggested that there is a connection; the results showed that green motivation enhances the innovation of ecological products and services. Bibi (2022) focused on

analyzing the effect of green transformational leadership on green innovation in the manufacturing industry. In practical terms, this suggests that consumer commitment can partially mediate the relationship between a brand's advertising and its impact on stock pricing for investors, while in theoretical terms, this supports prior research on the importance of consumer commitment to brands.

Besides, Abbas (2024) analyzed the effect of GTL on the firm performance and sustainability of supply chains. The outcomes revealed that green transformational leadership substantially influenced GSCM practices and OSP, whereas transactional leadership weakened its association. According to Thi et al. (2024), the study investigated the influence of green transformational leadership (GTL), green human resource management (GHRM), and green innovation (GI) on sustainable performance, which encompassed economic, social, and environmental aspects. Through a multi-respondent survey the data was collected. The end results indicated that GTL positively impacts GHRM practices and GI, while GI positively correlated with Sustainable Performance. Nevertheless, the study does not substantiate the association between GHRM and sustainable performance. Luo et al. (2024) analyzed the implementation of green transformational leadership in Pakistan's healthcare sector using Green Human Resource Management (GHRM) practices. The end results indicated that Green Training, Job Analysis, Intellectual Stimulation, and Green Product Innovation significantly influence environmental policies and regulations. The investigation underscored the significance of enacting safety health standards to alleviate environmental consequences. Based on the above literature reviews, the study developed current hypotheses:

H1: GTL has substantial impact on the green innovation.

H2: GTL has substantial impact on the firm sustainable performance.

H6: GI substantially mediates the relationship between GTL and firm sustainable performance.

Green Entrepreneurship Orientation, Green Innovation and Firm Sustainable Performance

A green entrepreneurial orientation promotes creative environmental self-efficacy, a favorable environmental attitude, and new ecological initiatives (W. Zhang et al., 2020). The study's goal, according to Mondal et al. (2024), was to find out how corporate social responsibility (CSR), green entrepreneurial orientation (GEO), policy awareness (PA), and personal innovativeness (PI) affect the long-term performance (SP) of Indian manufacturing MSMEs. The results indicated direct relationships between CSR and PA, mediated by green innovation with moderation. Tung & Baird (2023) investigated various drivers and contingencies that contribute to understanding the association between the green entrepreneurial orientation and the sustainable performance of Australian manufacturing organizations, particularly in response to stakeholder pressures. A cross-sectional survey of 560 CFOs confirmed a strong positive relationship between stakeholder pressure and firms' sustainable performance. Furthermore, the results suggest an inverse relationship between the consequent changes in environmental and financial performance. Thus, the results highlighted the importance of environmental processes' effectiveness amplification for increasing performance. Haripatworo et al. (2023) conducted a quantitative study on the impact of green entrepreneurial orientation on sustainable fashion MSMEs' competitive advantage in Semarang. The results highlighted that go-green entrepreneurial orientation has a massive influence on green innovation and competitive advantage; nevertheless, green innovation does not mediate the relationship.

In a study of green entrepreneurial orientation and green performance in manufacturing organizations in the UAE, Baquero (2024) looked at the link between green

EO and green performance. Upon analyzing the findings to establish mediation, the researcher found that green innovation, which encompasses both explorative and exploitative types, mediates the relationship between a firm's capacities to embrace two forms of creativity and enhances its competitive edge. Resource orchestration capability enhances green entrepreneurial orientation, strengthening the positive connection between green EO and green performance. The study suggested that the following can help in attaining sustainable performance: key environmental strategies and ambitious green innovation. Musfar et al. conducted an analysis to link green entrepreneurial orientation and green innovation with sustainable business performance, arguing that further research and improved measurement tools are necessary to enhance sustainable business practices. Based on the above literature reviews, the study developed current hypotheses:

H3: GEO has substantial impact on the green innovation.

H4: GEO has substantial impact on the firm sustainable performance.

H7: GI substantially mediates the association between GEO and firm sustainable performance.

Green innovation and Firm Sustainable Performance

Green innovation refers to the creation of new applications, goods, providers, or systems that improve resource efficiency while also being environmentally friendly (Habib & Scullion, 2020). Abbas (2024) conducted a study with the objective of assessing the relationship between CSR and green innovation with regard to the SP and GEO of the Indian manufacturing MSMEs. The findings substantiate the hypothesis of a positive relationship between CSR and PA. It proved useful to firm management and policymakers, as the research provided insights into the topic. Liu & Liu (2024) investigated the impact of green innovation on Chinese firms listed in A-share from 2010 to 2021. That is why the results showed that SG and significant green innovation have a positive influence on the company's financial performance, whereas strategic green innovation has a negative effect. That is why strategic green innovation is more effective than the simple improvement of environmental performance. The research also revealed that the extent of substantive green innovation has a lesser impact on the business earnings of state-owned enterprises and regions with more environmental issues.

Cheng et al. (2024) focused the analysis and synthesis of research on GI's effect on the firm's environmental and financial outcomes. This established the fact that pollution prevention technologies can reduce environmental pollution during production while also improving firms' financial performance. Pollution control technologies, on the other hand, may reduce production's environmental impact, but they will not improve financial performance. The study revealed that green innovation adds value and positively impacts future performance. Natalie et al. (2024) studied the effects of green innovation on the sustainable performance of micro, small, and medium-sized food and beverage enterprises in Bandar Lampung City. It stressed the alignment of sustainable business performance with green product innovation, and green process innovation demonstrated an even bigger positive relationship with sustainable performance.

Majid & Farooq (2024) investigated the relationship between green innovation performance, environmental commitment, and green marketing strategies adopted by US firms. It used both quantitative and qualitative data collection techniques to recruit 35 senior managers and 320 cross-sectional firms. Thus, the research findings pointed out those green marketing strategies have a positive impact in terms of innovation as well as commitment to the environment, which in turn improves business performance. The study noted that using green marketing strategies can enhance a firm's efficiency and ensure its longevity, catering to the demands of an environmentally conscious society. According to Qalati et al. (2023) conducted a study that examined the moderating

role of environmentally sustainable practices on firm performance, green employee integration, environmental sustainability, and employee environmental orientation. The study's analysis of 320 manufacturing employees using a closed-ended questionnaire confirmed the direct effect of ESP on GEI, ES, and FP. The study confirmed the partial mediation of GEI and ES, as well as the moderation of EEO on the ESP. Managers therefore need to integrate Financial Performance connections and green practice variables, aiming to improve the firm's performance and minimize societal impacts. Based on the above literature reviews, the study developed current hypotheses:

H5: Green innovation has substantial impact on the firm sustainable performance.

Environmental Concerns as a Moderator

Zhou et al. (2023) demonstrated that the study looked at the effects of environmental regulations on green innovations in China's Eleventh Five-Year Plan. Analyzing the findings, the researcher noted that regulation increases both the production and improvement of green innovations where the regulation intensity is high and/or where the pollution intensity is high. However, regulations can also lead to firms exiting markets or migrating to low-pollution industries. According to Li (2023), environmental damage has been substantial due to high carbon and corrosion in industrial development. Since 1978, governments have implemented environmental safety guidelines and laws to facilitate green transformation and innovation, as "sustainable development" was introduced. Academic circles have researched the subject of environmental regulation's influence on green innovation. Presenting prospects for future research, the study summarized the current status and shortages and analyzed extant research on environmental concerns in green innovation.

S. Chen (2024) investigated the relationship between consumers' environmental concerns and the rivalry between petroleum and new energy vehicles in a two-stage supply system. It employed a game theoretical model, which is a two-period model, to analyze the effect of such concerns on supply chain performance, social value, behavioral pricing, and strategic competition. The conclusions show that consumers' environmental concerns are useful in competing for market share among new energy vehicle manufacturers, and green innovation is helpful in improving supply chain management in three models. Chukwurah et al. (2024) scrutinized the correlation between environmental concerns and green technologies, emphasizing their influence on stakeholder implications and sustainability objectives. It also emphasized the challenges and opportunities and offered strategic recommendations for integrating rigorous environmental concerns without compromising the environmental benefits of green technology. Similarly, many other studies revealed same results demonstrated the impact of environmental concerns on the green innovation (Wu et al., 2023; Zappal et al., 2023; G. Zhang, 2023). Based on the above literature reviews, the study developed current hypotheses:

H8: Environmental concerns significantly moderate the relationship between the GTL and green innovation.

H9: Environmental concerns significantly moderate the relationship between the GEO and green innovation.

Research Model

The research model is a graphical representation of the association between the dependent and explanatory variables. Therefore, the primary objective has been identified and incorporated into the research methodology to attain empirical results. The model's dependent variable is sustainable performance; the independent variables are GTL and GEO. The variable of mediation of GI and moderating is environmental concerns. Figure 1 depicts the study model.

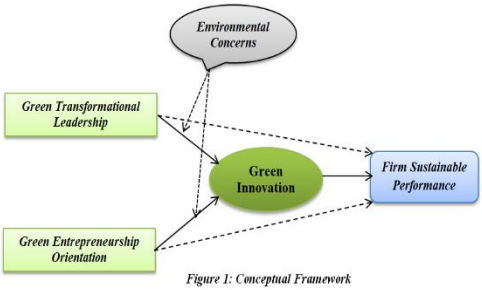

Figure 1: Conceptual Framework

Research Method

The primary purpose of this quantitative research is to investigate the effect of GTL and GEO on the FSP in the Saudi Arabia manufacturing sector. Moreover, it will investigate the mediation role of GI and the moderating effect of EC. Regarding this, the concept of sustainability is significant for all business concerns, specifically the manufacturing industry, due to the imposition of environmental regulations all over the world. Therefore, the present study employed a quantitative method to examine the association among the variables. Consequently, the current study utilized a purposive sampling method to administer an online questionnaire to 325 employees at various management levels of 56 manufacturing firms. The target population of this study consists of all manufacturing firms operationalized in Saudi Arabia. Regarding this, fifty-six manufacturing firms were drawn as samples.

Measurement of Variables

The current study employed scales that had already reached maturity. The questionnaire is split into two sections. The first section consists of demographic information related to participants. Whereas the second section consisted of a questionnaire adapted to determine responses to the research model, two questions related to all variables were adopted. For this purpose, the current study employed a five-point Likert scale: 1 represents strongly disagree, 2 represents disagree, 3 represents neutral, 4 represents agree, and 5 represents strongly agree. Therefore, (Y. Chen et al., 2014) six items were employed to assess green transformational leadership, and (Kraus et al., 2018) six items were employed to assess green entrepreneurship orientation. Furthermore, the current study employed six items to assess firm sustainable performance developed by (Lüdeke-freund & Hansen, 2023), five items used to assess green innovation developed by (Y.-S. Chen, 2008), and five items used to measure the environmental concern developed by (Jones, 2016).

Analysis Techniques

Furthermore, according to (Hair et al. 2014; Henseler et al., 2015), Smart-PLS is a well-known software application for PLS-SEM (partial least squares equational modeling). According to Sarstedt et al. (2014), have discovered that PLS-SEM improves the analysis and results interpretations by simplifying the incorporation of complex research model properties. The current study employed PLS-SEM (partial least squares structural equation modeling) as a data analysis technique. PLS-SEM was chosen because of the PLS-SEM method for efficiently and accurately handling formative and reflective assessment models and single-item constructs. As a result, it is easily adaptable to various educational environments. Numerous research studies have shown that PLS-SEM (partial least squares structural equation modeling) improves the statistical accuracy of parameter estimates.

Analysis and Findings

Demographic Analysis

The findings of descriptive analysis depicts in Table 1.

Table 1: Findings of Demographic Analysis

Variable		Frequency	Percentage
Gender	Male	214	65.85%
	Female	111	34.15%
Age	21-20	74	22.77%
	31-40	121	37.33%

	41-50	67	20.62%
	51-60	63	19.38%
Education			
	Bachelors	143	44.00%
	Master	87	26.77%
	M.Phil.	74	22.77%
	PhD	21	6.46%
Management Level			
	High Level	121	37.23%
	Medium level	101	31.08%
	Low Level	72	22.15%
	Other	31	9.54%

Convergent Reliability and Validity

This study used Cronbach's alpha (CA) coefficient to determine the reliability of the constructs. Convergent validity of each construct was assessed through the analysis of the composite reliability (CR). For purpose of the measurement model, the following coefficients were utilized to analyze the correlations of the latent variables: Cronbach's alpha, and composite reliability. The results indicated that all the variables had a significant and a rather strong positive correlation relationship between them; thus, the reliability coefficients (Cronbach's alpha values) for all the used composite scores were above 0. 70. Peterson et al. (1994) recommended minimum threshold for the acceptance of reliability value. The dependability of all the metrics was over 0. 70 and considered acceptable. The authors also reviewed the convergent and discriminant validities in order to guarantee that all the constructs were fairly distinct. Following Hair et al. (2019) the AVE for each construct should be more than 0. It should be noted that studies included in category 5 can be considered as evidence of convergent validity. Based on the result of AVE analysis, all variables were accorded with values greater than 0.50. This measurement is described in table 2 below. Also, if the inter-item correlation is low, it implies that the items come from different universes and that the omission is needed to eliminate errors and unreliable measures Peterson et al., (1994).

Table 2: Findings of Convergent Reliability and Validity

Constructs	Items	Factor Loading	CA	CR (rho_a)	CR (rho_c)	AVE	VIF
Environmental Concerns	EC1	0.703	0.725	0.743	0.821	0.519	1.023
	EC2	0.839					3.354
	EC3	0.822					2.319
	EC4	0.787					1.114
	EC5	0.843					3.403
Firm Sustainable Performance	FSP1	0.850	0.887	0.906	0.916	0.650	2.693
	FSP2	0.872					4.354
	FSP3	0.870					3.916
	FSP4	0.739					1.322
	FSP5	0.823					2.568
	FSP6	0.832					2.938
Green Entrepreneurship Orientation	GEO1	0.443	0.862	0.914	0.902	0.619	1.177
	GEO2	0.878					3.069
	GEO3	0.762					1.276
	GEO4	0.926					2.135
	GEO5	0.912					2.829
	GEO6	0.862					2.878
Green Innovation	GI1	0.918	0.965	0.966	0.973	0.878	3.400
	GI2	0.929					3.398
	GI3	0.932					2.732
	GI4	0.968					2.843
	GI5	0.936					3.507
	GTL1	0.763	0.877	0.905	0.909	0.629	1.336

	GTL2	0.802	3.345
Green	GTL3	0.771	3.190
Transformation	GTL4	0.797	4.332
al Leadership	GTL5	0.868	3.035
	GTL6	0.910	2.618
Average Value of VIF			2.718

Discriminant Validity

The primary aim this study is to investigate the causal relationship between the variables. Hair Jr. et al. (2020) recommended using the Heterotrait-monotrait Ratio of Correlations (HTMT), Fornell Larker criterion, and cross-loading approaches to evaluate the discriminant validity of the study.

Hetrotrait-Monotrait Ratio of Correlations (HTMT)

To determine the discriminant validity of the study, Gold et al. (2001) employed Hetrotrait-Monotrait technique. Gold et al. (2001) proposed that the maximum value for HTMT is 0.90. Based on the results in Table 3, the present study indicates that discriminant validity is met because the HTMT value for each pair of constructs is less than 0.90. This shows a more significant correlation among items that test the same variable than other variables.

Table 3: Findings of Heterotrait-monotrait Ratio of Correlations (HTMT)

	EC	FSP	GEO	GI	GTL
EC					
FSP	0.544				
GEO	0.651	0.790			
GI	0.554	0.778	0.820		
GTL	0.578	0.540	0.840	0.677	

Fornell Larker Criterion

The Fornell & Larcker (1981) criterion is reliable for determining discriminant validity by studying cross-loading values. In the following research, it is necessary to analyze the correlation coefficient between each structural model. A desirable outcome is obtained when each construct's average variance extracted (AVE) exceeds its correlation values with other constructs (Hopkins, 2014). We accept the presence of discriminant validity using the Fornell-Larcker criterion. The AVE values for each construct in Table 4 corroborate this, as they outperform their correlation values with other constructs.

Table 4: Findings of Fornell Larker Criterion

	EC	FSP	GEO	GI	GTL
EC	0.406				
FSP	0.460	0.506			
GEO	0.529	0.406	0.487		
GI	0.495	0.511	0.407	0.537	
GTL	0.480	0.451	0.546	0.512	0.493

Cross Loading

Cross loading" refers to an object's ability to reflect or represent multiple measurements. Chin (1998) states that an outside loading value greater than 0.60 is acceptable or reasonable. Table 5 shows the investigation's outer loading value. Therefore, all item's values are greater than 0.60.

Table 5: Findings of Cross Loading

Items	EC	FSP	GEO	GI	GTL
EC1	0.703	0.373	0.475	0.434	0.415
EC2	0.839	0.322	0.387	0.330	0.351
EC3	0.822	0.354	0.372	0.359	0.346
EC4	0.787	0.147	0.181	0.147	0.152
EC5	0.843	0.304	0.306	0.329	0.293
FSP1	0.372	0.850	0.798	0.745	0.807
FSP2	0.396	0.872	0.740	0.821	0.845
FSP3	0.421	0.870	0.873	0.825	0.917
FSP4	0.296	0.739	0.504	0.482	0.451
FSP5	0.412	0.823	0.763	0.723	0.757
FSP6	0.320	0.832	0.663	0.752	0.737
GEO1	0.219	0.392	0.743	0.384	0.391
GEO2	0.403	0.870	0.878	0.840	0.859
GEO3	0.514	0.454	0.762	0.466	0.518
GEO4	0.439	0.856	0.926	0.809	0.898
GEO5	0.467	0.745	0.912	0.807	0.829
GEO6	0.469	0.806	0.862	0.820	0.820
GI1	0.401	0.890	0.810	0.918	0.910
GI2	0.478	0.808	0.838	0.929	0.801
GI3	0.469	0.780	0.858	0.932	0.829

GI4	0.486	0.882	0.842	0.968	0.868
GI5	0.485	0.897	0.900	0.936	0.858
GTL1	0.511	0.459	0.586	0.495	0.763
GTL2	0.238	0.729	0.663	0.707	0.802
GTL3	0.297	0.666	0.755	0.625	0.771
GTL4	0.419	0.784	0.835	0.677	0.797
GTL5	0.462	0.900	0.842	0.825	0.868
GTL6	0.401	0.890	0.810	0.918	0.910

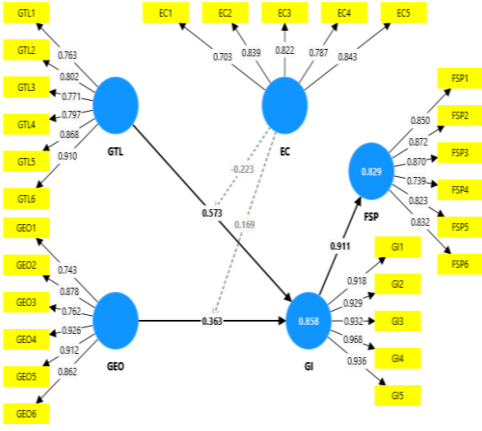

Figure 2: Measurement of Model
Note: GTL = Green Transformational Leadership, GEO = Green Entrepreneurship Orientation, GI = Green Innovation, EC = Environmental Concern and FSP = Firm Sustainable Performance

Direct Relationship

The current study used a PLS-SEM bootstrapping technique to investigate the causal association. The R-squared, T-statistic, beta coefficient value and p-value were used to evaluate the validity of structural equational modeling. Table 6 represents the t-statistics, p-values, and beta coefficients. There is a significant and positive impact of Green transformational leadership (GTL) on green innovation (GI). The results (Beta = 0.373, t = 6.016, p-value less than 0.05) provide evidence for the acknowledgement of hypothesis (H1) at a significance level of 5%. This finding confirms the previous studies (Al-Romeedy & El-Sisi, 2024; X. Chen et al., 2023; H. Green et al., 2023). Moreover, green transformational leadership (GTL) has a positive and significant impact on a firm sustainable performance (FSP). The results ($\beta = 0.222$, $t = 3.828$, p less than 0.05) provide evidence for the acceptance of hypothesis (H2) at a significance level of 5%. This finding confirms the previous studies (Abbas, 2024; Le et al., 2024; Luo et al., 2024; Qalam & Keagamaan, 2024; Sangadji & Islami, 2024; Thi et al., 2024). Furthermore, green entrepreneurship orientation (GEO) has a significant and positive impact on firm green innovation (GI). The results ($\beta = 0.263$, $t = 4.109$, $p < 0.05$) provide evidence for the acceptance of hypothesis (H3) at a significance level of 5%. This finding confirms the previous studies (Baquero, 2024; Chechel & Kldiashvili, 2024; Haripatworo et al., 2023; Musfar et al., 2024; Tung & Baird, 2023). In addition, green entrepreneurship orientation (GEO) has a significant impact on firm sustainable performance (FSP). The results ($\beta = 0.230$, $t = 3.898$, $p < 0.05$) provide evidence for the acceptance of hypothesis (H4) at a significance level of 5%. This finding confirms the previous studies (Abid et al., 2024; Marzouk & El Ebrashi, 2024; Rexhepi et al., 2023; X. Zhang et al., 2024). Further, green innovation (GI) has positive and significant and positive impact on firm sustainable performance (FSP). The results ($\beta = 0.031$, $t = 3.456$, p less than 0.05) provide evidence for the acceptance of hypothesis (H5) at a significance level of 5%. This finding confirms the previous studies (Cheng et al., 2024; Liu & Liu, 2024; Majid & Farooq, 2024; Mondal et al., 2024; Natalie et al., 2024; Qalati et al., 2023).

Table 6: Findings of Direct Relationship

Hypothesis	Beta Coeff.	Std. Dev.	t-Stat.	p-value	Decision
H1: GTL -> GI	0.373	0.062	6.016	0.000	Accepted
H2: GTL -> FSP	0.222	0.058	3.828	0.000	Accepted

H3:	GEO -> GI	0.263	0.064	4.109	0.000	Accepted
H4:	GEO -> FSP	0.230	0.059	3.898	0.000	Accepted
H5:	GI -> FSP	0.031	0.009	3.456	0.000	Accepted

Indirect Relationship

The present research used a PLS-SEM bootstrapping procedure to investigate the mediating effect. Table 7 shows the mediating or indirect effects results: green innovation (GI) mediated green transformational leadership (GTL) and the firm's sustainable performance (FSP) in the Saudi Arabia's manufacturing sector. The findings ($\beta = 0.522$, $t = 9.056$, $p < 0.05$) indicate the acceptance of the H6 hypothesis. Furthermore, green innovation (GI) mediated green entrepreneurship orientation (GEO) and the firm's sustainable performance (FS) in the Saudi Arabia's manufacturing sector. The results accept the H7 hypothesis at a significance level of 5% ($\beta = 0.330$, $t = 5.638$, $p < 0.05$).

Table 7: Findings of Indirect Relationship

Hypothesis	Beta Coeff.	Std. Dev.	t-Stat	p-Value	Decision
H6: GTL -> GI -> FSP	0.522	0.058	9.056	0.000	Accepted
H7: GEO -> GI -> FSP	0.330	0.059	5.638	0.000	Accepted

Moderating Effect

The current study utilized a PLS-SEM bootstrapping method to interrogate the moderating effect. Table 8 shows the results of the moderating influence. Environmental concerns (EC) significantly moderate the relationship between green transformational leadership (GTL) and a firm's sustainable performance (FSP) in the Saudi Arabia's manufacturing sector. At a 5% significance level, the H8 hypothesis is accepted ($\beta = 0.223$, $t = 3.152$, $p < 0.05$). Furthermore, environmental concerns (EC) have moderating impacts on the association between green entrepreneurial orientation (GEO) and a firm's sustainable performance (FSP) in the Saudi Arabia's manufacturing sector. At a 5% significance level, the findings ($\beta = 0.169$, $t = 2.487$, $p < 0.05$) support the H9 hypothesis.

Table 7: Findings of Moderating Effect

Hypothesis	Beta Coeff.	Std. Dev.	t-Stat.	p-value	Decision
H8: EC x GTL -> GI	0.223	0.071	3.152	0.002	Accepted
H9: EC x GEO -> GI	0.169	0.068	2.487	0.013	Accepted

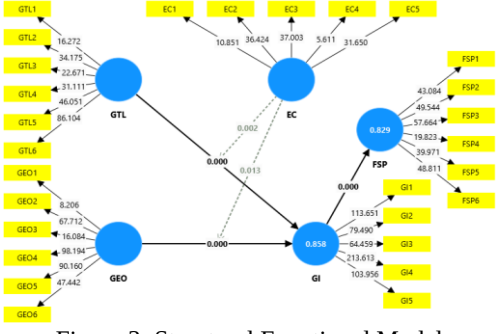

Figure 3: Structural Equational Model

Note: GTL = Green Transformational Leadership, GEO = Green Entrepreneurship Orientation, GI = Green Innovation, EC = Environmental Concern and FSP = Firm Sustainable Performance

Discussion, Conclusion and Policy Implication

Discussion

The green transforming leadership has significant impact on green innovation in manufacturing industries of Saudi Arabia. While

managing sustainability, leaders define the vision, create the motivation, enable the employees, support them, implement standards, encourage teamwork, and incorporate sustainability in organizational plans. It also encourages the thinking beyond the immediate future, rewards people for their work, and encourages people to come up with new ideas. This supports Saudi Arabia vision 2030, the company is partly aiming at providing jobs for citizen through diversification and environmental conservation. Manufacturing industries should spur green innovation that creates competitiveness, has a lesser negative impact on environment and supports the country's sustainable development goals. Appreciation of employee's effort on green innovation encourages sustainable practices by employees this because such appreciation motivates employees to ensure green innovation is given prominence.

This study reveals that green transformational leadership in Saudi Arabia's manufacturing industries has a positive effect on firm sustainable performance. Besides, it improves environmental aspects by establishing sustainable measures, establishing adherence to the policies implemented and encouraging the innovation process. This will result in an improvement in competitiveness and the attraction of environmentally friendly consumers and partners. Green transformational leaders also enable employees to increase their job satisfaction and organizational commitment. This is important as they create trust and loyalty with the stakeholders, hence boosting their reputation score and creating synergy. It aligns sustainability with strategic objectives in such a way that sustainability is the organizational goal. Therefore, sustainable practices work out economically as the costs are reduced, and they become useful in attracting funds, which makes the business financially stable, making it a prospect for growth. Green transformational leaders are consciously aware of market trends concerning sustainability and effectively create opportunities for firms to work in a green environment.

This study examines green entrepreneurship orientation in Saudi Arabia's manufacturing industries and its impact on green innovation because proactiveness, risk-taking, innovativeness, competitive aggressiveness, and autonomy all play a role. These entrepreneurs are the actors who are looking for the market niches for eco-efficient goods and services, technological innovations, and inspirations. They also encourage the use of technology, betterment of the supply chain, and compliance with rules and regulations. The guidance of this reorientation is compatible with the Saudi Arabia vision, which focuses on the diversification of the economy, protection of the environment, as well as strategic competitiveness

Green entrepreneurship orientation in Saudi Arabia's manufacturing industries contributes to improving firm sustainable performance by linking environmental sustainability and business growth strategies. Cultivating awareness and understanding of this orientation will help build sustainable processes, develop and deliver innovation and better financial performances and employee and stakeholder engagements, handle risks, and improve relationships with Saudi Arabia's Vision 2030. Thus, by promoting the principles of the 3R model, waste reduction, energy efficiency, and the use of renewable resources, GEO encourages compliance with legislation, the initiation of new business activities and the achievement of competitive advantage.

Therefore, green innovation becomes important due to its positive impact on the enhancement of the firm's sustainable performance of manufacturing firms. It also improves efficiency by cutting the use of resources and emissions to the environment and supports sustainable products. It also results in operational effectiveness, cost optimization, market advantage, compliance with various laws and regulations, managing risks, improving organizational profitability and stakeholders'

satisfaction, staff morale, and managing relationships with different stakeholders. Green innovation also plays its part in extending economic diversification and sustainability, developing the world economy, and providing firm competitiveness in the global market, which is becoming environmentally conscious, guaranteeing the long-term sustenance of firms.

The findings of this study highlight the mediating impact of green innovation between green transformational leadership and firm sustainable performance relationship in the manufacturing sector of Saudi Arabia. Therefore, green innovation earns an organization the required improvements in its firm sustainable performance. These are benefits that relate to the business in terms of bottom-line improvement through optimization of expenses as well as market capture. These benefits have to do with the environment, which may include a decrease in emissions and waste, and lastly, benefits that concern the society, including relations with the people in the community. This way, the leaders provoke changes within their organizations that would motivate the achievement of sustainable development goals. For practical activity, the main directions are identified in the field of leadership development, integration of sustainability concepts, and focus on green innovation to strengthen competitive advantages.

Moreover, the mediation analysis reveals that green innovation partially mediates the green entrepreneurship orientation and firm sustainable performance relationship. This means that the net positive effect of green entrepreneurship on performance is partly through the route of innovation endeavors. A study shows that firms that opt for green innovation notice an enhanced sustainable performance. This comprises of business returns, for instance, cost-cutting, which reduces expenses and gains a bigger market share; environmental returns, for example, emission of less greenhouse gases and wastes; and lastly, societal returns, for instance, working closely with society. Hence, the promotion of green entrepreneurship increases the chances of firms or industries to come up with new innovative teachings towards the achievement of so desired sustainable developments. The practical consequences scrutinize the importance of encouraging new environmentally friendly enterprise initiatives, incorporation of sustainability in business as well as stress on innovation as the key to superior competitive superiority.

Furthermore, the findings of the current study reveal that the environmental concern as a moderator in the green transformational leadership and firm sustainable performance relationship. This contributes to the literature by proving that the relationship between leadership and firm sustainable performance results depends on the environmental concern of the organization. The current study also found that the green transformational leadership of the firms has a positive and incremental effect on environmental concerns within the firms in the manufacturing sector of Saudi Arabia. Therefore, the outcome is higher in firms that focus more on the environment. Further, promoting environmental concern at the top level of organizational executive management can facilitate green transformational leadership by the firms in order to gain better results in sustainability performance. Whereas the practical considerations stress raising the awareness of environmental issues by the leaders, advancing the green transformational leadership, and incorporating environmental concern into the strategic management

Finally, the current study found that environmental concern enhances the green entrepreneurship orientation and firm sustainable performance relationship. Large environmental concern firms' customers derive higher value from their green entrepreneurial activities than firms with low environmental concern. Consequently, the study shows the moderating effect of environmental concern in increasing the impact of green entrepreneurship

orientation on the sustainable performance of firms in Saudi Arabia. It builds on that by adding environmental concern as a control variable that affects the nature and extent of the relationship between entrepreneurship and performance. By establishing corporate environmental concern, firms would amplify the success of green entrepreneurial activities within firms and consequently deliver superior levels of sustainable performance. This is to stress the pragmatic concerns related to sensitization for environmental conservation, fostering environmental-friendly business ventures and environmental sensibility in management planning.

Conclusion

This quantitative study will examine the impact of green entrepreneurship and transformational leadership on organizational sustainability, utilizing Saudi Arabia's manufacturing industry as a case study. This essay also covers the function of environmental concerns as moderators and green innovation as a facilitator. The data analysis technique used in this study was Partial Least Squares Structural Equation Modeling (PLS-SEM). Green transformational leadership in Saudi Arabia's manufacturing industries significantly impacts green innovation. Leaders define the vision, motivate employees, and incorporate sustainability into organizational plans. This approach supports Saudi Arabia's Vision 2030, aiming to provide jobs for citizens through diversification and environmental conservation. Green transformational leaders create opportunities for sustainable practices, enhancing firm sustainable performance and aligning sustainability with strategic objectives. Green entrepreneurship orientation in Saudi Arabia's manufacturing industries contributes to improving firm sustainable performance by linking environmental sustainability and business growth strategies. Cultivating awareness and understanding of this orientation helps build sustainable processes, develop and deliver innovation, improve financial performance, employee and stakeholder engagement, risk management, and relationships with Saudi Arabia's Vision 2030. Green innovation partially mediates the green transformational leadership and firm sustainable performance relationship, with the net positive effect partly through innovation endeavors. Environmental concern also moderates the relationship between leadership and firm sustainable performance. Promoting environmental concern at the top level of organizational executive management can facilitate green transformational leadership and enhance the impact of green entrepreneurship orientation on sustainable performance.

Implications

Policy Implications

Based on the research conclusions of this study, some policy recommendations are as follows to propose improved sustainable performance in manufacturing sector sectors, especially in Saudi Arabia. Due to this, policymakers should encourage the implementation of green transformational leadership and green entrepreneurship orientation as two of the main strategies for attaining environmental sustainability and enhanced economic growth. Policies that encourage green innovation can help realize the use of environment-friendly practices and products, hence cutting emissions and wastage. Furthermore, the incorporation of environmental issues in corporate governance and business strategies can improve the efficiency of these green programs. Therefore, development of a favourable regulatory structure opens a window through which manufacturing firms within a country can enhance sustainable competitive advantage cum sustainable development in the creation and implementation of its environmental policies.

Practical Implications

Based on the findings of this study, the practical implications advocate for the role of GTL and GEO in the improvement of FSP. Chief executives whose plans are ecological can

change the perception of other employees to adopt ecological cultures in an organisation. This can translate to the formation of new ideas that help manage environmental degradation, such as generating environmentally friendly products and procedures. About GEO, firms can also increase their financial performance by considering cost savings and the constantly rising demand for sustainable products. Moreover, the interaction between them is such that green innovation has a moderation role, strengthening the impacts of GTL and GEO on FSP. Managers and policymakers should promote green leadership and entrepreneurial orientation, infuse the organisation with green innovations, and deal with environmental factors to obtain sustainable performance as a whole and for the long term. Furthermore, this approach complies with global ecological standards while improving the firm's image, competitive position, and sustainability in the market.

Limitations and Future Directions

However, there are some limitations to this study that need to be noted. The data is self-reported and is collected from a specific sector and a specific region, so the results may need to be more generalizable. Future research should recruit participants through a cross-sectional design, including different types of organizations and geographical areas, to confirm the findings. Also, the study is hypothesis-driven because other variables apart from those presented in the study might affect sustainable performance. Future research should include a more comprehensive number of variables, and the designs should be long-term to explore the dynamics of the situation. Additionally, more attention to cultural and institutional characteristics would advance knowledge related to the ways in which these factors influence the implementation of green initiatives as well as their results.

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