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## Green entrepreneurial orientation and environmental performance a moderated mediation perspective of perceived environmental innovation and stakeholder pressure

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The current research examines how green entrepreneurial orientation affects environmental performance in Pakistan's manufacturing industries. It also examines the function of environmental innovation as a mediator in this relationship. In addition, stakeholder pressure is a moderating variable between green entrepreneurial orientation and environmental performance. For the current investigation, we employ structural equation modeling as a model estimation technique. The participants' data were gathered using a random sampling technique, and 208 questionnaires were subsequently analyzed. Results show that green entrepreneurial orientation increases environmental performance. In addition, the influence of green entrepreneurial orientation on environmental performance is significantly mediated by environmental innovation. The study's moderating impact revealed that green entrepreneurial orientation affects environmental performance through environmental innovation and that stakeholder pressure validates its contribution to environmental performance. This study focuses on how green entrepreneurial approaches and environmental innovation are impacted by increasing stakeholder pressure for better environmental performance. Drawing on stakeholders' theory and natural resource-based view theory. The present research provides new insights into green entrepreneurial orientation and environmental innovation for sailing toward environmental performance. It develops a theoretical framework model emphasizing the connections between green entrepreneurial orientation, environmental innovation, and stakeholder pressure and their impact on environmental performance.

**Keywords** Green entrepreneurial orientation, Environmental innovation, Stakeholder pressure, Environmental performance

As the worldwide ecological crisis intensifies countries like Pakistan face significant environmental challenges caused by global climate change, such as changing seasonal weather patterns, rising temperatures, shifting monsoons, and glacier melting<sup>1</sup>. Given that firms are attempting to develop alternatives that lessen the environmental risks associated with their operations innovation and environmental sustainability have become vital ideas that must be thoroughly integrated into management and coordination processes within organizations<sup>2</sup>. Green product innovation can drive business success and improve environmental performance<sup>3,4</sup>.

Sustainable development is a concept that focuses on tackling environmental, economic, and social challenges raising the question: how to do it? This article focuses on a study of eco-innovation, defined by the OECD (2009) as

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new industrial techniques, products, services, and knowledge-based innovations that enable firms to implement sustainable practices<sup>5–7</sup>. As a result, more and more companies are recognizing their social responsibility and gradually integrating environmental management into their internal planning and operations<sup>8–10</sup>.

A firm with a green entrepreneurial orientation is committed to being proactive, taking calculated risks, and utilizing innovation to identify opportunities that benefit the overall economy and the natural environment. Previous studies have focused on defining the environmental limitations and analyzing the drivers of green innovation from stakeholders' perspectives, the needs of consumers, advances in technology, and expected outcomes as drivers of innovation to the environment<sup>11–15</sup>. Our research aims to examine the connection between green entrepreneurial orientation and environmental performance since limited studies have been conducted on this subject. Green entrepreneurial orientation is one environmentally friendly business strategy that could encourage environmental innovation. Green entrepreneurial orientation enables enterprises to mitigate the harmful ecological effects caused by their operations<sup>16,17</sup>. This is important because examining the GEO-EP link does not just fill a noticeable research gap but also provides insight into how entrepreneurial modes of addressing sustainability translate into environmental performance. How the nature of this relationship can be comprehended may enable an organization to position its green strategies toward better environmental performance, inform policy development, and enhance overall sustainability efforts<sup>18</sup>. This underlines the fact that proactive, green-oriented entrepreneurial practices might be one of the critical drivers of environmental performance improvement.

To address the gaps in the existing literature, we have developed an integrated model that combines the natural resource-based view (NRBV) theory and stakeholder theory. This model focuses on three key areas: (1) the direct effects of green entrepreneurial orientation on environmental performance; (2) the role of environmental innovation as a mediator between green entrepreneurial orientation and environmental performance; and (3) the moderating influence of stakeholder pressure on the relationship between green entrepreneurial orientation and environmental innovation. We collected survey data from 208 manufacturing firms in Pakistan's top industrial cities to test our conceptual model. By linking green entrepreneurial orientation and environmental performance and incorporating stakeholder pressure and environmental innovation into our model, our findings contribute to the expanding body of research on clean production.

## Theoretical background and hypotheses development

### Green entrepreneurial orientation perspective

Green entrepreneurial orientation and environmental entrepreneurial orientation are two interrelated distinct concepts. EEO emphasizes strategies and procedures that aim to convert and identify possibilities related to sustainable development for creating new value, taking into account expenses, threats, and uncertainties, while the green entrepreneurial orientation approach is characterized by an organization's willingness to take proactive, and innovative steps to improve both the firm and its operating environment<sup>19–23</sup>. Therefore, green entrepreneurial orientation refers to businesses' willingness to engage in profitable, environmentally responsible, and socially beneficial ventures. This relates to enterprises' activities and process modifications to search for environmentally friendly procedures, goods, and services by configuring their resources within and outside<sup>16,24</sup>. Thus, we will focus on how the green entrepreneurial orientation stance affects environmental performance. Several authors argue that green entrepreneurial orientation can assist firms in restructuring their corporate structure to produce green products or procedures and demonstrate exceptional environmental performance<sup>25</sup>.

The choice of definition matters when it comes to environmental innovation, if only because the idea of the innovation being used significantly influences how its impact is viewed. According to<sup>26</sup> environmental innovation refers to developing new products and procedures that offer value to consumers and businesses and substantially reduce ecological harm. According to<sup>27</sup>, environmental innovation is a specific innovation that improves ecological sustainability. In another study by<sup>8</sup>, environmental innovation uses technology in trash recycling, energy conservation, pollution avoidance, and green product design. Furthermore, environmental innovation enables businesses to enhance their competitive edge, as proposed by the ecological modernization theory and the Porter hypothesis, environmental innovation, or environmental innovation, allows businesses to improve their capacity to compete<sup>28,29</sup>. However, the critical distinction between conventional and green innovation lies in their unique externalities. The environmental spillover effect during the adoption and dissemination stage predominantly characterizes traditional innovation.

In contrast, green innovation is primarily marked by the impact of innovation spillover during the R&D and innovation stage<sup>30</sup>. Therefore, the expansion of environmental innovation is contingent upon the business's internal strategic resources. This highlights the importance of examining the impact of innovation drivers on eco-innovation behavior and other relevant firm characteristics.

### Natural resource-based view theory and Stakeholders theory

An increasing amount of uncertainty in the social, environmental, and economic spheres forces organizations to develop and put into practice proactive strategies that concentrate on the innovation of the environment<sup>31–37</sup>. According to the NRBV theory, a company's core competency is determined by its ability to acquire green corporate resources that are valuable, rare, non-replaceable, or only partially imitable<sup>38</sup>. Drawing on the NRBV and relevant previous research, this study proposes that green entrepreneurial orientation, as a strategic resource, can help firms improve their traditional development mode by adopting an environmentally proactive, safe, or innovative orientation that supports implementing environmental innovation.

The study examines the role of stakeholder pressure in influencing the impact of green entrepreneurial orientation on environmental innovation under the theoretical lens of stakeholder theory. Stakeholders influence a firm's activities at multiple levels. Research has shown that building relationships with stakeholders is crucial for organizations to gain support for their strategic initiatives and achieve desired outcomes<sup>39–42</sup>. Studies

by<sup>43–45</sup> discuss the reasons behind corporate actions that promote environmental management, sustainability, corporate social responsibility, and environmental protection. In another place, studies demonstrate that increased stakeholder pressure reduces companies' irresponsible behavior and improves their environmentally responsible operations<sup>46–49</sup>.

Stakeholder pressure from internal and external sources can encourage businesses to embrace environmental strategies, influencing environmental innovation and fostering inventive solutions to ecological issues. Organizations must follow tight environmental protection rules and regulations to avoid sanctions, with government policies essential in assuring legality and legitimacy. According to<sup>50</sup>, stakeholder theory suggests that firms should regularly monitor and address stakeholder concerns. Therefore, the pressure exerted by stakeholders may compel companies to develop new strategies to reduce pollution emissions, conserve energy, maximize resource utilization, and manufacture sustainable products<sup>51</sup>. While the influence of stakeholder pressure on adopting a sustainability approach in the green entrepreneurial orientation-environmental innovation connection has not been extensively researched. This study used environmental innovation as a mediator between green entrepreneurial orientation and environmental performance in light of stakeholder theory. Figure 1 demonstrates stakeholder's significant impact on a company's environmental initiatives.

### Green entrepreneurial orientation and environmental performance

Businesses with a strong green entrepreneurial orientation should prioritize their entrepreneurial orientation, which focuses on enterprise development, the triple-bottom-line principle emphasizing ecological protection. Research suggests that green entrepreneurial orientation has a meaningful and positive impact on a company's economic and environmental performance<sup>52,53</sup>. Enterprises seek to develop a green entrepreneurial orientation to enhance available resources while meeting societal goals such as eliminating negative ecological consequences<sup>54</sup>. Green entrepreneurial orientation is a perspective on strategy and behavioral preference that combines entrepreneurial orientation with the development of environmental value<sup>55</sup>, prioritizing the strategic approaches firms use to achieve financial, ecological, and societal objectives. Green entrepreneurial orientation reduces resources and manufacturing costs while enhancing GI, resulting in outstanding business performance. Recent research has demonstrated that green entrepreneurial orientation plays a crucial role in strengthening economic success while simultaneously minimizing negative ecological impacts<sup>56–58</sup>. Furthermore, a study conducted by<sup>59</sup> has revealed that green entrepreneurial orientation significantly improves environmental performance.

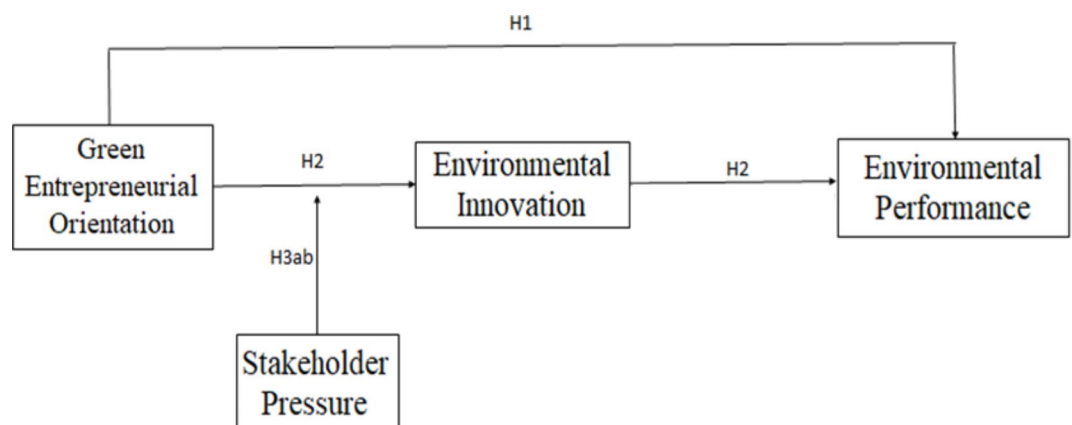
Similarly,<sup>60</sup> reject that environmental performance and green entrepreneurial orientation are directly correlated. Firms employing green entrepreneurial orientation can adopt various approaches to increase their environmental performance. To solve environmental issues, green entrepreneurial orientation first creates environmentally friendly products and services<sup>61</sup>. Second, minimizing hazardous emissions or dangerous substances improves worker safety and health<sup>16</sup>. Third, focusing on consumer health and safety improves the well-being of society<sup>62,63</sup>.

Moreover, according to the NRBV theory<sup>38</sup>, successful businesses must identify and effectively utilize their existing natural resources. Companies can creatively integrate their resources by adopting an innovative environmental orientation, ensuring efficient distribution. Consequently, implementing green entrepreneurial orientation aims to combat ecological deterioration by manufacturing and offering environmentally friendly products that enhance environmental performance<sup>64</sup>. Therefore, based on the above analysis, we propose the following hypothesis.

*Hypothesis 1: Green entrepreneurial orientation has a positive significant impact on environmental performance.*

### Environmental innovation role as a mediator

Businesses have the potential to boost product value and gain a competitive edge by replacing inefficient and wasteful methods with innovative and improved mechanisms, technologies, activities, and products<sup>29</sup>. The Ecological Modernization Theory (2000) proposes that companies can promote a greener society by embracing



**Fig. 1.** Theoretical framework model.

eco-friendly innovation, enabling them to attain economic and environmental success. Environmental innovation plays a crucial role in addressing ecological pressures. “Green practices, such as using eco-friendly products, adopting innovative technologies, modernizing systems, fostering environmentally conscious skills, creating sustainable workplaces, and promoting resource efficiency, can help achieve these objectives<sup>16,18,65</sup>.” According to<sup>66</sup>, environmental innovation refers to the processes and techniques businesses use to reduce environmental harm and drive economic development. Suggest<sup>67</sup> that a company's green image reflects its substantial responsibility towards environmental issues. Therefore, in line with the recommendation by NRBV researchers, this study examines environmental innovation as the dynamic capabilities of a firm aimed at enhancing environmental efforts and adopting the external natural environment. According to NRBV, environmental innovation involves the processes of monitoring and managing eco-friendly goods, reducing pollution, and ultimately fostering an environmentally friendly ecosystem<sup>38,66</sup>.

Therefore, as<sup>68</sup> suggested, environmental innovation aids green entrepreneurial orientation in achieving superior environmental performance. Consequently, EEO may incentivize firms to implement environmental innovation, enhancing their environmental performance. The utilization of environmental innovation to improve environmental performance is prevalent among businesses prioritizing environmental risk management, innovation, and proactive ecological operations. Therefore, given the analysis provided above, we suggest the following.

*Hypothesis 2: Environmental innovation significantly mediates the green entrepreneurial orientation and environmental performance.*

### Stakeholder pressure role as a moderator

The stakeholder theory states that firms aim to meet the environmental demands of stakeholders, which drives the formulation of proactive or advanced ecological strategies. According to<sup>69</sup>, stakeholder pressure forces businesses to reconsider their planning and consider environmental issues while making decisions. Various writers have concentrated their investigations on identifying and categorizing “green stakeholders,” who can affect firms’ environmental policies. The empirical findings from the study by<sup>70</sup> indicated a substantial direct correlation between stakeholder pressure and sustainability. The impact of green entrepreneurial orientation on environmental innovation may be increased by stakeholder pressure, forcing firms to modify their strategies and practices to satisfy stakeholder requests for better environmental protection. According to studies, pressure from stakeholders can force businesses to take action on environmental problems<sup>71</sup>, execute proactive measures to manage the environment<sup>72</sup>, find creative ways to reduce pollution emissions, reduce energy, enhance resource efficiency, and create eco-friendly products<sup>51</sup>. Therefore, mobilizing stakeholders may help advance green entrepreneurial orientation policies and environmental innovation initiatives. Stakeholder pressure may strengthen green entrepreneurial orientation's impact on environmental innovation. Based on the analysis provided above, we propose the following.

*Hypothesis 3a: Stakeholder pressure significantly influences the direct effect of green entrepreneurial orientation on environmental innovation, with higher pressure increasing the influence of green entrepreneurial orientation on environmental innovation.*

Based on hypotheses H2 and H3a, in light of the evidence concerning a moderated mediating influence, we consider the following.

*Hypothesis 3b: Stakeholder pressure moderates the influence of environmental innovation on the link between green entrepreneurial orientation and environmental performance, with higher stakeholder pressure increasing the moderating effect.*

## Methodology

### Sample and data collection

The main objective of this study is to examine manufacturing firms in Pakistan, with a particular focus on the cities of Faisalabad, Gujrat, Sialkot, Hattar, Gadoon, and Islamabad. These firms operate in various industries such as food, textile, clothing, fashion, pharmaceutical, sports, metal, chemical, leather, and plastic. A questionnaire was developed to collect data about the companies’ descriptive statistics (industry type, department, workforce size, employee position, etc.), green entrepreneurial orientation, environmental innovation, stakeholder pressure, and environmental performance. We constructed our questionnaire using tested scales that matched the parameters of our study to assure validity and reliability. Additionally, all the methods were performed according to the relevant guidelines and regulations provided by the ethical committee of the School of Economics and Management (SWFU). The survey questionnaire was designed both in English and Urdu for better understanding. The survey items were revised, followed by pre-investigation by scholars and experts, we carried out a pilot study involving managers and decision-makers occupying mid to top-level positions within the company. The questionnaires were revised according to the feedback.

We used the measurement scales introduced by<sup>16,73,74</sup> to assess green entrepreneurial orientation. For measuring environmental innovation, we employed a 5-item scale developed by<sup>72,75,76</sup>. Stakeholder pressure was evaluated using a 4-item scale created by<sup>13,72,75,77</sup>. The Environmental Performance questionnaire, which included a 4-item scale, was developed by<sup>62,74</sup>. The internationally recognized ISO 14001 (EMS) standard, CO2 emissions, and economy were included as control variables. We defined the economy as developed, developing, or underdeveloped based on previous studies referencing ISO 14001<sup>78</sup>, based on the industries and manufacturing sectors and the contribution of CO2 levels to the environment. The study utilized a 5-point Likert scale for all

measurements of the study constructs with options ranging from 1 = strongly disagree to 5 = strongly agree<sup>79–82</sup>. Table 1 shows convergent validity.

In the next step, from each of the selected cities, Faisalabad, Gujrat, Sialkot, Hattar, Gadoon, and Islamabad, we choose a sample of 500 industries according to their type, size, and age. We distributed questionnaires to these 500 industries to maximize survey response rates using the University of Faisalabad's resources and personal connections. We identified a key person for each of the firms who generally has a crucial role in the firm. Before sending out the questionnaires, we contacted these individuals by phone or WhatsApp. Additionally, we included a concise cover letter with each questionnaire, clarifying the study's objectives and assuring participants of their anonymity. Additionally, we made follow-up calls and sent messages one month after distributing the initial questionnaires to improve the response rate. The completed questionnaires were sent directly to the authors to protect the respondent's confidentiality.

Out of the 296 questionnaires we received back, 208 were completed and considered satisfactory, resulting in a response rate of 41.6%. Table 2 shows the descriptive characteristics of both the participants and the represented firms. We performed a t-test to compare the unique attributes of the firms that responded and those that did not. The study's findings revealed no notable distinctions between responded and non-responded firms and no notable distinctions between early (120) and later (176) responses, indicating no non-response bias. We surveyed senior managers with expertise in environmental management, ensuring their knowledge to provide reliable data to address standard method variance (CMV) aligns with the study of<sup>83</sup>. We used Harman's single-factor test to detect CMV and found five distinct variables, with the highest accounting for 22.68% of the variance. However, none of these variables could account for a substantial amount of the variability, indicating a low risk of CMV.

Reliability and validity

Initially, the authors used exploratory factor analysis (EFA) to examine the factor structure of the analyzed items. The results identified four factors that correlated with each variable. The four-factor solution accounted for 79.0% of the total variance in all 18 items. Scale reliability was assessed by calculating Cronbach's alpha values and determining composite reliability (CR) using confirmatory factor analysis (CFA) factor loadings. Then, we examined average variance extracted (AVE) values for convergent validity. Table 1 illustrates that each construct had an AVE of at least 0.616 and a CR of at least 0.852. The theoretical constructs demonstrate satisfactory reliability and convergent validity, as indicated by a Cronbach's alpha coefficient of 0.855.

Furthermore, we assessed the suitability of the four-factor models by analyzing their latent variables. Confirmatory factor analysis (CFA) results for all four models, including the one presented in Table 3, demonstrated a perfect fit with the data ( $X^2/df = 2.043$ , SRMR = 0.037, GFI = 0.923, NFI = 0.941, IFI = 0.968, TLI = 0.963, CFI = 0.967, RMSEA = 0.051). In contrast, the other models fell short of meeting the essential criteria for adequacy, suggesting that each variable maintained its distinctiveness and was thus suitable for inclusion in the analysis. Table 4 provides the variables' averages and standard deviations (SDs). R<sup>2</sup> is the variance explained by all the exogenous constructs<sup>84,85</sup>.

Constructs	Items	Factor Loading	AVE	CR	Cronbach's $\alpha$
Green entrepreneurial orientation			0.790	0.935	0.934
	GEO1	0.864			
	GEO2	0.915			
	GEO3	0.886			
	GEO4	0.867			
	GEO5	0.862			
Environmental innovation			0.681	0.915	0.913
	EI1	0.819			
	EI2	0.778			
	EI3	0.906			
	EI4	0.792			
	EI5	0.823			
Stakeholder pressure			0.616	0.887	0.883
	SP1	0.848			
	SP2	0.871			
	SP3	0.854			
	SP4	0.746			
Environmental performance			0.662	0.852	0.855
	EP1	0.809			
	EP2	0.807			
	EP3	0.824			
	EP4	0.833			

Table 1. Convergent validity.

Characteristics	Frequency	Percentage
Type of industry		
Food and beverages	31	14.90
Textile, clothing and fashion	40	19.23
Pharmaceutical	29	13.94
Sports	26	12.50
Metal	20	9.62
Chemical	24	11.54
Leather	21	10.10
Plastic industries	17	8.17
Enterprise size		
50–99	42	20.20
100–299	59	28.36
300–499	77	37.02
500 above	30	14.42
Gender of respondents		
Male	163	78.37
Female	45	21.63
Age of respondents		
25 above	40	19.23
30–40	85	40.86
40–45	46	22.12
Over 45	37	17.79
Position		
Senior executives	29	13.94
Executives	37	17.79
Senior managers	54	25.96
Managers	88	42.31
Tenure in years		
3–6	93	44.71
7–8	77	37.02
Above 10	38	18.27

**Table 2.** Demographic statistics.

Models	X <sup>2</sup> /df	SRMR	GFI	NFI	IFI	TLI	CFI	RMSEA
Four-Factor Model	2.043	0.037	0.923	0.941	0.968	0.963	0.967	0.051
Three-Factor Model	9.963	0.105	0.635	0.703	0.725	0.687	0.726	0.148
Two-Factor Model	16.044	0.158	0.355	0.517	0.532	0.476	0.531	0.190
One-Factor Model	22.131	0.204	0.442	0.331	0.340	0.265	0.339	0.225

**Table 3.** Confirmatory factor analysis. Note: Four-factor model: green entrepreneurial orientation, SP, EI, and EP. Three-factor model: Four-factor model + green entrepreneurial orientation + EI. Two-factor model: Four-factor model + green entrepreneurial orientation + EI + EP. One-factor model: All four factors + green entrepreneurial orientation + EI + EP + SP.

The discriminant validity was evaluated via the Fornell and Lacker Criterion to assess the comparison of correlation between constructs with the square root of the AVE of the constructs. As shown in Table 5, the diagonals' bolded values were higher than the values in their respective row and columns, thus indicating that the measures used in this study were discriminant.

## Analysis and results

### Test of mediation effect

We utilized SPSS22.0 software for hierarchical regression and AMOS22.0 for bootstrapping to evaluate the mediation effect. The findings from the multiple regression analysis are illustrated in Table 6. Specifically, Model 5 demonstrates that green entrepreneurial orientation positively influences environmental innovation ( $\beta = 0.384, p < 0.001$ ), thus affirming the hypothesis (H1).



Variables	Correlation matrix								
	Mean	SD	1	2	3	4	5	6	7
1-ISO 14,001	2.041	0.931	1						
2-Co <sub>2</sub> emission	2.221	1.072	0.094	1					
3-Economy	0.412	0.492	0.078*	0.085	1				
4-Green entrepreneurial orientation	3.268	1.375	0.062	0.038	0.005	1			
5-Environmental innovation	4.162	1.708	0.017	0.016	0.015	0.448**	1		
6-Stakeholder pressure	3.756	1.084	0.071	0.042	0.005	0.125*	0.075	1	
7-Environmental performance	4.754	1.465	0.015	0.008	0.148**	0.382**	0.454**	0.046	1

**Table 4.** Pearson correlation. Note: \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

Variables	EP	GEO	EI	SP
EP	0.81			
GEO	0.71	0.88		
EI	0.73	0.70	0.83	
SP	0.62	0.67	0.59	0.79

**Table 5.** Discriminant validity.

Variables	Environmental innovation			Environmental performance		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Demographic						
ISO 14001	0.017 (0.090)	−0.012 (0.081)	−0.005 (0.078)	0.005 (0.075)	−0.018 (0.072)	−0.002 (0.068)
Co <sub>2</sub> emission	0.016 (0.078)	0.000 (0.072)	−0.002 (0.066)	−0.005 (0.069)	−0.019 (0.061)	−0.012 (0.060)
Economy	0.013 (0.174)	0.019 (0.153)	0.012 (0.147)	0.148** (0.145)	0.153** (0.133)	0.144*** (0.129)
Main effect						
GEO		0.446*** (0.057)	0.402*** (0.058)		0.384*** (0.047)	0.231*** (0.039)
EI						0.454*** (0.038)
SP			−0.108* (0.066)			
Interaction effect						
GEO × SP			0.207*** (0.049)			
R <sup>2</sup>	0.001	0.202	0.255	0.021	0.166	0.224
Δ R <sup>2</sup>	−0.007	0.194	0.246	0.015	0.161	0.028
F value	0.096	25.824***	23.492***	3.043*	20.733***	27.795***

**Table 6.** Hierarchical regression. Note: \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

Following<sup>86</sup> guidelines, we conducted a four-step mediation analysis. Firstly, we established a strong relationship between the independent variable (green entrepreneurial orientation) and the dependent variable (environmental performance). Models 4 and 5 of Table 6 indicated that the association between green entrepreneurial orientation and environmental performance was positive and significant ( $\beta_{1/4} = 0.384$ ,  $p < 0.001$ ). Models 1 and 2 in Table 6 also demonstrated that green entrepreneurial orientation positively impacted environmental innovation ( $\beta_{1/4} = 0.446$ ,  $p < 0.001$ ). In the second step, we examined the relationship between the independent variable (green entrepreneurial orientation), the mediator (environmental innovation), and the dependent variable (environmental performance). Model 6 in Table 6 revealed a significant positive association between environmental innovation and environmental performance ( $\beta = 0.454$ ,  $p < 0.001$ ). Although the positive correlation between green entrepreneurial orientation and environmental innovation remained consistent ( $\beta = 0.231$ ,  $p < 0.01$ ), the significance level slightly decreased compared to Model 5, providing general support for H2.

To further confirm H2, the study uses the PROCESS macro in SPSS to perform bias-corrected bootstrapping on Model 4<sup>87</sup>. The results are displayed in Table 6 and reveal that, with a 95% confidence interval of [0.036, 0.109], excluding zero, the indirect effect of green entrepreneurial orientation on environmental performance through environmental innovation is 0.184. Hence, environmental innovation effectively mediates green entrepreneurial orientation influence on environmental performance and supports H2.

### Test of moderating effect

The study employed multiple regression analysis with PROCESS to examine how stakeholder pressure influences the relationship between green entrepreneurial orientation and environmental innovation, establishing confidence intervals. Model 3 in Table 6 revealed that the interaction terms of green entrepreneurial orientation and stakeholder pressure positively impacted environmental innovation ( $\beta = 0.207$ ,  $p < 0.001$ ). Figure 2 demonstrates the moderating role by illustrating the relationship between green entrepreneurial orientation and environmental innovation at various levels of stakeholder pressure (high, medium, and low). Thus, these findings support hypothesis 3a, indicating that high stakeholder pressure enhances the positive correlation between green entrepreneurial orientation and environmental innovation.

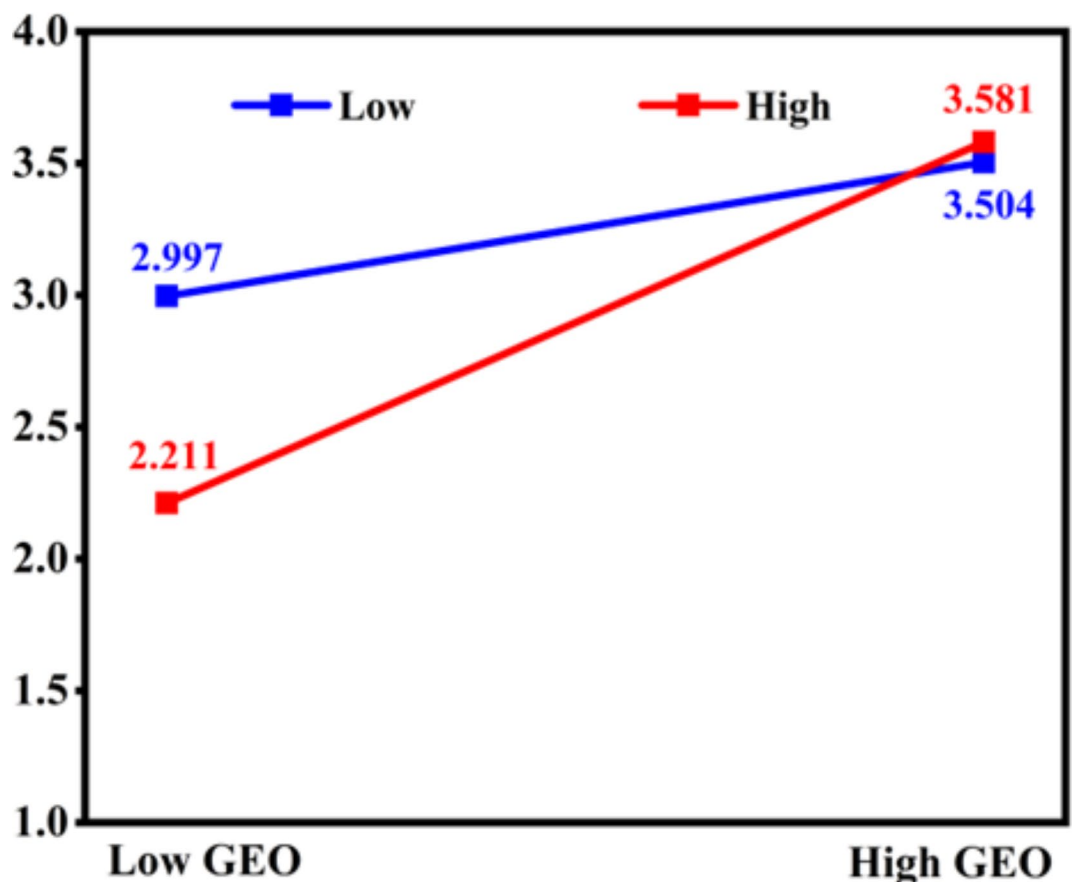
### Test of the moderated mediating effect

Finally, we examined the moderated mediating effect, explicitly focusing on the conditional indirect effect with stakeholder pressure as the moderating variable. Table 7 presents the results, showing that the indirect influence of green entrepreneurial orientation on environmental performance through environmental innovation is more substantial when stakeholder pressure is high ( $\beta = 0.235$ , 95% BC CI = [0.162, 0.327]) compared to low stakeholder pressure conditions ( $\beta = 0.081$ , 95% BC CI = [0.022, 0.165]). The moderated mediating effect index is calculated as 0.069, with a 95% confidence interval of [0.036, 0.109], indicating a significant and positive moderated mediating effect. These findings confirm hypothesis H3b, demonstrating that increased stakeholder pressure enhances the impact of green entrepreneurial orientation on environmental performance through environmental innovation.

### Discussion and conclusion

This study explores a theoretical framework that connects green entrepreneurial orientation with environmental performance through environmental innovation, considering the moderating effect of stakeholder pressure in major industrial cities in Pakistan. Besides assessing the direct impact of green entrepreneurial orientation on environmental performance through environmental innovation, this study also examines how stakeholder pressure may moderate this relationship. A sample of 500 manufacturing industries was chosen to test and validate the hypotheses.

The study's findings support H1, indicating a positive relationship between green entrepreneurial orientation and environmental performance, which aligns with previous studies by<sup>62,88–92</sup>. Developing environmental



**Fig. 2.** The moderating effect of stakeholder pressure between green entrepreneurial orientation and environmental performance.



Path	95% BC CI			
	Effect	SE	Lower	Upper
Test of mediating effects				
Through EI	0.184	0.031	0.122	0.248
Total effect	0.334	0.495	0.237	0.431
Test of moderated mediation effect				
High SP	0.235	0.041	0.162	0.327
Medium SP	0.161	0.031	0.107	0.234
Low SP	0.081	0.035	0.022	0.165
Index of moderated mediation	0.069	0.018	0.036	0.109

**Table 7.** Bootstrapping for mediation. Note: Bootstrapping sample = 1000.

sustainability concepts aims to utilize internal capabilities to achieve environmentally sound performance<sup>93,94</sup>. Furthermore<sup>95</sup>, emphasized the importance of evaluating how organizational sustainability concepts might influence actions leading to environmentally friendly performance. Additionally, our analysis has shown that environmental innovation significantly mediates the relationship between green entrepreneurial orientation and environmental performance, thus supporting H2. These findings are consistent with previous studies by<sup>96–98</sup>, which indicate that innovation strengthens the connection between environmental performance. In another study by<sup>62</sup>, it is recommended that manufacturing industries in Pakistan prioritize environmental innovation to enhance environmental performance. Additionally, our findings corroborate<sup>38</sup> natural resource perspectives on RBV and emphasize the vital importance of resources in achieving successful environmental outcomes. Thus, businesses that develop specific valuable resources to deal with environmental constraints must have higher environmental performance.

Additionally, the research finds that stakeholder pressure has a favorable moderating influence between green entrepreneurial orientation and environmental performance, supporting H3a. This finding is consistent with the ecological theory perspective, which holds that legislation protection laws can combine environmental performance and economic success<sup>99</sup>. This study posits that stakeholder pressure has a contributing role in influencing environmental performance. In the relationship between green entrepreneurial orientation and environmental performance, stakeholder pressure positively moderated a mediating link with environmental innovation, and H3b was accepted. This indicates that as stakeholder pressure increases, it positively moderates the relationship between green entrepreneurial orientation and environmental innovation, consistent with prior studies<sup>72,100,101</sup>. This study supports all direct and indirect hypotheses, providing valuable theoretical and practical insights.

**Theoretical implication**

This research makes several significant contributions to the existing literature. Firstly, it introduces a theoretical framework based on the natural Resource-Based View (NRBV) for analyzing the positive connection between green entrepreneurial orientation and environmental innovation. Furthermore, the results of this study support previous research conducted by<sup>102</sup>, which found a positive relationship between green entrepreneurial orientation and environmental performance. Furthermore, a study by<sup>9</sup> illustrates how their environmental ethics can positively impact manufacturing firms’ competitive advantage. Our comprehension of green entrepreneurial orientation is limited because of the absence of theoretical models relating it to environmental performance. The natural resource-based view (NRBV) theory is widely recognized as a critical framework for studying strategic management. This study focuses on its application to green entrepreneurial orientation, which combines environmental and entrepreneurial orientations. This study aims to outline and validate the green entrepreneurial orientation-environmental innovation-environmental performance model. The model examines how green entrepreneurial orientation influences a firm’s environmental innovation practices and their subsequent impact on environmental performance within the RBV framework. Therefore, this study provides an explanation and validation of the positive relationships discussed from the perspective of NRBV.

This study contributes to the existing literature on clean production by establishing a robust connection between green entrepreneurial orientation, green innovation (environmental innovation), and environmental performance. Previous research has confirmed the positive impact of green entrepreneurial orientation on environmental sustainability and performance i-e<sup>9,64–66,103–105</sup>, as well as its relationship with firm performance<sup>67,106,107</sup>. However, it remains unclear whether green entrepreneurial orientation can affect environmental performance through environmental innovation. The main finding of this study is that green entrepreneurial orientation enhances environmental performance by utilizing environmental innovation as a mediator. The study, which collected data from 208 Pakistani manufacturing firms, reveals that environmental innovation partially mediates the relationship between green entrepreneurial orientation and environmental performance. This finding is consistent with prior research<sup>88–92</sup>, which also highlighted the significance of environmental innovation in various contexts. By highlighting firms’ environmentally innovative efforts from an internal organizational ethical perspective, this result provides valuable insights into the literature on clean production.

Thirdly, this study contributes to stakeholder theory by introducing stakeholder pressure as a moderating factor in the relationship between green entrepreneurial orientation and environmental innovation. Consistent with previous research, stakeholder pressure positively influences firms' sustainability efforts<sup>72,100,101</sup>. However, existing studies have primarily focused on the direct effects of stakeholder pressure, leaving the interaction between green entrepreneurial orientation and environmental innovation relatively unexplored, particularly regarding effective environmental strategies. This study highlights the significance of stakeholder pressure as a boundary condition in the green entrepreneurial orientation-environmental innovation relationship, illustrating that stakeholder pressure enhances the positive impact of green entrepreneurial orientation on environmental innovation. Additionally, the study examines how stakeholder pressure may affect the effect of green entrepreneurial orientation and environmental innovation on environmental performance, building on previous research<sup>72,100,101</sup>.

### Practical implication

The study's findings offer valuable insights for manufacturing firms striving for environmentally sustainable performance, representing a significant practical implication. Specifically, the results underscore the crucial role of green entrepreneurial orientation in fostering environmental innovation and enhancing environmental performance. Therefore, manufacturing firms are encouraged to prioritize developing and cultivating an ecological culture and allocate resources toward fostering green entrepreneurial orientation. Businesses that allow their internal environmental ethics procedures complete control might encourage green innovation. To maintain environmental responsibility, top managers are essential to any organization. So, green entrepreneurial orientation should encourage entrepreneurial initiative and leadership during implementation while advocating for a strategic approach considering economic, environmental, and social factors<sup>108</sup>.

Furthermore, our research findings suggest that environmental innovation significantly mediates green entrepreneurial orientation and environmental performance. Therefore, firms are advised to consistently enhance their innovative strategies and remain mindful of the impact of environmental innovation across the manufacturing process. Moreover, organizations should focus on improving knowledge acquisition and absorption to foster the development of green knowledge. This facilitates gathering knowledge about sustainability within the organization and allows for green innovation initiatives. To promote these initiatives, companies should provide tools and opportunities, foster an environmentally conscious culture, and encourage employee involvement. Additionally, businesses should prioritize interaction and collaboration with the outside world to facilitate the sharing and implementation of relevant environmental innovation and the adoption of advanced technologies from external sources. Consequently, firms can cultivate green and sustainable business models capable of achieving performance across economic, environmental, and social dimensions, thereby overcoming technological, industrial, and organizational challenges.

The research highlights the importance of stakeholder pressure in promoting environmentally responsible practices and emphasizes the impact of external factors on environmental performance and proactive environmental initiatives. Enterprises concentrate on coordinating economic, social, and ecological outcomes as stakeholder demand for management grows. Businesses should take environmental issues seriously and fulfill social responsibilities to expand and seize market opportunities. Government regulations, along with pressure from customers and competitors, can encourage businesses to implement eco-friendly practices due to the enforcement of environmental standards. Managers and staff should take into account other stakeholders' environmental concerns. Meanwhile, firms should adopt a sustainable development perspective to create a green entrepreneurial orientation that is innovative, pioneering, environmentally, and socially conscious, given the rapid changes in the environment.

### Limitations and future directions

The research investigated the green entrepreneurial orientation mechanism in terms of environmental performance theoretically and empirically, yielding valuable insights while also underscoring the need for further exploration and research to address its limitations in the future. Firstly, the data are only collected from selected manufacturing enterprises in selected industrial cities in Pakistan. Future research should investigate the variation in green entrepreneurial orientation implementation across different countries and fields with varying institutional contexts. Secondly, the questionnaire developed for this study is only suitable for manufacturing industries; hence, future studies could focus on both industrial and service enterprises. Third, the data collection process for this study involves top-line managers or executives; in future studies, we can relate to and involve top, middle, or team. Nonetheless, future studies should also improve stakeholders' views, as personal ties, values, and modes do not evaluate these strengths and characteristics.

### Data availability

The data involved in the study can be provided upon request from the corresponding author/authors for any reasonable reason.

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### References

1. De Marchi, V. J. Environmental innovation and R&D cooperation: empirical evidence from Spanish manufacturing firms. *Res. Policy* **41**(3), 614–623 (2012).
2. Korhonen, J. Four ecosystem principles for an industrial ecosystem. *J. Clean. Prod.* **9**(30), 253–259 (2001).

3. Xing, J. et al. The finest diamond must be green: a closer look at the roles of institution in shipping firms' sustainable practices. *Environ. Sci. Pollut. Res.* **30**(35), 84631–84644 (2023).
4. Su, M., Fang, M., Pang, Q. & Park, K. S. Exploring the role of sustainable logistics service providers in multinational supply chain cooperation: an integrated theory-based perspective. *Front. Environ. Sci.* **10**, 976211 (2022).
5. Baumgartner, R. J. & Ebner, D. Corporate sustainability strategies: sustainability profiles and maturity levels. *Sustain. Dev.* **18**(2), 76–89 (2010).
6. Verghese, K. & Lewis, H. J. Environmental innovation in industrial packaging: a supply chain approach. *Int. J. Prod. Res.* **45**(18–19), 4381–4401 (2007).
7. Antonioli, D., Mancinelli, S. & Mazzanti, M. Is environmental innovation embedded within high-performance organisational changes? The role of human resource management and complementarity in green business strategies. *Res. Policy* **42**(4), 975–988 (2013).
8. Chen, Y. S., Lai, S. B. & Wen, C. T. The influence of green innovation performance on corporate advantage in Taiwan. *J. Business Ethics* **67**, 331–339 (2006).
9. Chang, C.-H. The influence of corporate environmental ethics on competitive advantage: the mediation role of green innovation. *J. Business Ethics* **104**, 361–370 (2011).
10. Chen, Y.-S. The driver of green innovation and green image—green core competence. *J. Business Ethics* **81**(116), 531–543 (2008).
11. Zailani, S., Govindan, K., Iranmanesh, M., Shaharudin, M. R. & Chong, Y. S. Green innovation adoption in automotive supply chain: the Malaysian case. *J. Clean. Prod.* **108**, 1115–1122 (2015).
12. Hojnik, J. & Ruzzier, M. J. The driving forces of process eco-innovation and its impact on performance: insights from Slovenia. *J. Clean. Prod.* **133**, 812–825 (2016).
13. Cai, W.-G. & Zhou, X. L. On the drivers of eco-innovation: empirical evidence from China. *J. Clean. Prod.* **79**, 239–248 (2014).
14. Huang, X., Hu, Z., Liu, C., Yu, D. & Yu, L. F. The relationships between regulatory and customer pressure, green organizational responses, and green innovation performance. *J. Clean. Prod.* **112**, 3423–3433 (2016).
15. Cai, W. & Li, G. J. The drivers of eco-innovation and its impact on performance: Evidence from China. *J. Clean. Prod.* **176**, 110–118 (2018).
16. Jiang, W., Chai, H., Shao, J. & Feng, T. Green entrepreneurial orientation for enhancing firm performance: a dynamic capability perspective. *J. Clean. Prod.* **198**, 1311–1323 (2018).
17. Leonidou, L. C., Christodoulides, P., Kyrgidou, L. P. & Paliawadana, G. Internal drivers and performance consequences of small firm green business strategy: the moderating role of external forces. *J. Business Ethics* **140**, 585–606 (2017).
18. Riaz, A. & Ali, F. H. Responsible innovation and sustainable competitive advantage: is big data the missing link?. *Business Process Manage. J.* **30**, 1213–1235 (2024).
19. Hummels, H. & Argyrou, A. Planetary demands: redefining sustainable development and sustainable entrepreneurship. *J. Clean. Prod.* **278**, 123804 (2021).
20. Shepherd, D. A., Patzelt, H. J. & Practice. The new field of sustainable entrepreneurship: studying entrepreneurial action linking “what is to be sustained” with “what is to be developed”. *Entrepreneurship Theory Practice* **35**, 137–163 (2011).
21. Belz, F. M., Binder, J. K. & Environment, T. Sustainable entrepreneurship: A convergent process model. *Business Strategy Env.* **26**, 1–17 (2017).
22. Cohen, B. & Winn, M. I. Market imperfections, opportunity and sustainable entrepreneurship. *J. Business Venturing* **22**(1), 29–49 (2007).
23. DiVito, L. & Bohnsack, R. J. Entrepreneurial orientation and its effect on sustainability decision tradeoffs: the case of sustainable fashion firms. *J. Business Venturing* **32**(5), 569–587 (2017).
24. Halder, S. & Management, E. Towards a conceptual understanding of sustainability-driven entrepreneurship. *Corporate Soc. Responsib. Environ. Manage.* **26**(6), 1157–1170 (2019).
25. Teece, D. Dynamic capabilities and entrepreneurial management in large organizations: toward a theory of the (entrepreneurial) firm. *Eur. Econ. Rev.* **86**, 202–216 (2016).
26. Fussler, C. & James, P. J. Driving eco-innovation: a breakthrough discipline for innovation and sustainability. (1996).
27. Klemmer, P. & Lehr, F. *Environmental Innovation: Incentives and Barriers: German Ministry of Research and Technology (BMBF) (Analytica, 1999).*
28. Zhu, Q., Sarkis, J., Lai, K. & Management, T. Green supply chain management innovation diffusion and its relationship to organizational improvement: an ecological modernization perspective. *J. Eng. Technol. Manage.* **29**(1), 168–185 (2012).
29. Porter, M., Van der Linde, C. J. & Advantage, C. Green and competitive: ending the stalemate. *Environ. Regul. Compet. Adv.* **33**, 120–134 (1995).
30. Rennings, K. J. Redefining innovation—eco-innovation research and the contribution from ecological economics. *Ecol. Econ.* **32**(2), 319–332 (2000).
31. Aragón-Correa, J. A. & Rubio-Lopez, E. A. Proactive corporate environmental strategies: myths and misunderstandings. *Long Range Plan.* **40**(3), 357–381 (2007).
32. Porter, M. E., Kramer, M. R. & Corporate. Strategy & society. *Harvard Business Rev.* **84**(12), 78–92 (2006).
33. Eiadat, Y., Kelly, A., Roche, F. & Eyadat, H. Green and competitive? An empirical test of the mediating role of environmental innovation strategy. *J. World Business* **43**(2), 131–145 (2008).
34. Alt, E., Díez-de-Castro, E. P. & Lloréns-Montes, F. Linking employee stakeholders to environmental performance: The role of proactive environmental strategies and shared vision. *J. Business Ethics*, **128**, 167–181 (2015).
35. Sharma, S. *Competing for a Sustainable World: Building Capacity For Sustainable Innovation* (Routledge, 2017).
36. Nidumolu, R., Prahalad, C. K. & Rangaswami, H. Why sustainability is now the key driver of innovation. *Harvard Business Rev.* **87**(9), 56–64 (2009).
37. Bhupendra, K. V. & Sangle, S. What drives successful implementation of pollution prevention and cleaner technology strategy? The role of innovative capability. *J. Environ. Manage.* **155**, 184–192 (2015).
38. Hart, S. L. A natural-resource-based view of the firm. *Acad. Manage. Rev.* **20**(4), 986–1014 (1995).
39. Greenley, G. E. & Foxall, G. Multiple stakeholder orientation in UK companies and the implications for company performance. *J. Manage. Stud.* **34**(2), 259–284 (1997).
40. Freeman, R. E. In *R. Edward Freeman's Selected Works on Stakeholder Theory and Business Ethics*. Cambridge University Press 301–317 (Springer, 2023).
41. Harrison, J. S. & Wicks, A. C. Stakeholder theory, value, and firm performance. *Business Ethics Q.* **23**(1), 97–124 (2013).
42. Lee, R. P. & Susan, W. Antecedents of adopting corporate environmental responsibility and green practices. *J. Business Ethics* **148**, 397–409 (2018).
43. Eesley, C. & Lenox, M. J. Firm responses to secondary stakeholder action. *Strategic Manage. J.* **27**(8), 765–781 (2006).
44. Jakhar, S. K., Mangla, S. K., Luthra, S. & Kusi-Sarpong, S. When stakeholder pressure drives the circular economy: Measuring the mediating role of innovation capabilities. *Manage. Dec.* **57**(4), 904–920 (2019).
45. Sarkis, J., Gonzalez-Torre, P. & Adenso-Diaz, B. Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. *J. Oper. Manage.* **28**(2), 163–176 (2010).
46. Hörisch, J., Freeman, R. E., Schaltegger, S. J. O. & Environment, H. Applying stakeholder theory in sustainability management: Links, similarities, dissimilarities, and a conceptual framework. *Org. Env.* **27**(4), 328–346 (2014).

47. Rondinelli, D. & Berry, M. J. Multimodal transportation, logistics, and the environment: managing interactions in a global economy. *Eur. Manage. J.* **18**(4), 398–410 (2000).
48. Rodrigue, M., Magnan, M. & Boulianne, G. Stakeholders' influence on environmental strategy and performance indicators: A managerial perspective. *Manage. Account. Res.* **24**(4), 301–316 (2013).
49. Steuerer, R., Langer, M. E., Konrad, A. & Martinuzzi, G. Corporations, stakeholders and sustainable development I: a theoretical exploration of business–society relations. *J. Business Ethics* **61**, 263–281 (2005).
50. Ferrell, O., Gonzalez-Padron, T. L., Hult, G. T. M. & Maignan, I. M. From market orientation to stakeholder orientation. *J. Public Policy Market.* **29**(1), 93–96 (2010).
51. Liu, L., Chen, C., Zhao, Y., Zhao, E. J. R. & Reviews, S. E. China's carbon-emissions trading: overview, challenges and future. *Renew. Sustain. Energy Rev.* **49**, 254–266 (2015).
52. Clemens, B. Economic incentives and small firms: does it pay to be green? *J. Business Res.* **59**(4) 492–500 (2000).
53. Zeng, P. The relationship among knowledge innovation, dynamic capabilities and organizational performance: a structural equation model analysis. *Stud. Sci. Sci.* **27**(8), 1271–1280 (2009).
54. Luo, X., Zhou, L. & Liu, S. Entrepreneurial firms in the context of China's transition economy: an integrative framework and empirical examination. *J. Business Res.* **58**(3), 277–284 (2005).
55. Hughes, P., Hodgkinson, I. R., Hughes, M. & Arshad, D. Explaining the entrepreneurial orientation–performance relationship in emerging economies: the intermediate roles of absorptive capacity and improvisation. *Asia Pac. J. Manage.* **35**, 1025–1053 (2018).
56. Ameer, F. & Khan, N. R. Green entrepreneurial orientation and corporate environmental performance: a systematic literature review. *Eur. Manage. J.* **41**(5), 755–778 (2023).
57. Hamdoun, M. The antecedents and outcomes of environmental management based on the resource-based view: a systematic literature review. *Int. J.* **31**(2), 451–469 (2020).
58. Zahoor, N., Gerged, A. M. & Environment, t. Relational capital, environmental knowledge integration, and environmental performance of small and medium enterprises in emerging markets. *Business Strategy Env.* **30**(8), 3789–3803 (2021).
59. Wang, Z., Zhang, J. & Development & Sustainability. Nexus between corporate environmental performance and corporate environmental responsibility on innovation performance. *Env. Dev. Sustain.* **25**(10), 11645–11672 (2023).
60. Tang, Z. & Tang, J. Stakeholder corporate social responsibility orientation congruence, entrepreneurial orientation and environmental performance of Chinese small and medium-sized enterprises. *Br. J. Manage.* **29**(4), 634–651 (2018).
61. Ameer, F. & Khan, N. R. Manager's age, sustainable entrepreneurial orientation and sustainable performance: a conceptual outlook. *Sustainability* **12**(8), 3196 (2020).
62. Habib, M. A., Bao, Y., & Ilmudeen, A. Management: the impact of green entrepreneurial orientation, market orientation and green supply chain management practices on sustainable firm performance. *Cogent Business Manage.* **7**(1), 1743616 (2020).
63. Asad, M., Asif, M. U., Bakar, L. J. A. & Sheikh, U. A.I. 2021 *International Conference on Decision Aid Sciences and Application (DASA)*. In *2021 International Conference on Decision Aid Sciences and Application* 797–802 (IEEE, 2021).
64. Nordin, R., Hassan, & R. A. Research, E. The role of opportunities for green entrepreneurship towards investigating the practice of green entrepreneurship among SMEs in Malaysia. *Rev. Integr. Business Econ. Res.* **8**, 99–116 (2019).
65. Guo, Y., Wang, L. & Chen, Y. Green entrepreneurial orientation and green innovation: the mediating effect of supply chain learning. *Sage Open* **10**(1), 2158244019898798 (2020).
66. Rehman, S. U. et al. Analyzing the relationship between green innovation and environmental performance in large manufacturing firms. *Technol. Forecast. Soc. Change* **163**, 120481 (2021).
67. Tang, M. et al. Green innovation, managerial concern and firm performance: an empirical study. *Business Strategy Env.* **27**(1), 39–51 (2018).
68. Corrocher, N., & Solito, I. I. How do firms capture value from environmental innovations? An empirical analysis on European SMEs. *Entrepreneurship Theory Practice*, **16**(1), 569–585 (2017).
69. Kassinis, G. & Vafeas, N. Stakeholder pressures and environmental performance. *Acad. Manage. J.* **49**(1), 145–159 (2006).
70. Darnall, N. Why firms mandate ISO 14001 certification. *Business Soc.* **45**(3), 354–381 (2006).
71. Jennings, P. D. & Zandbergen, P. A. Ecologically sustainable organizations: an institutional approach. *Acad. Manage. Rev.* **20**(4), 1015–1052 (1995).
72. Lee, J. W., Kim, Y. M. & Kim, Y. E. Antecedents of adopting corporate environmental responsibility and green practices. *J. Business Ethics* **148**, 397–409 (2018).
73. Xia, H. Relationship between green entrepreneurial Orientation, Positive market orientation and innovation performance of technology start-ups. *Sci. Technol. Manage. Res.* **16**, 264–274 (2019).
74. Muangmee, C., Dacko-Pikiewicz, Z., Meekaewkunchorn, N., Kassakorn, N. & Khalid, B. Green entrepreneurial orientation and green innovation in small and medium-sized enterprises (SMEs). *Soc. Sci.* **10**(4), 136 (2021).
75. Li, D. et al. The impact of legitimacy pressure and corporate profitability on green innovation: evidence from China top 100. *J. Clean. Prod.* **141**, 41–49 (2017).
76. Aldieri, L., Carlucci, F., Cirà, A., Ioppolo, G. & Vinci, C. P. Is green innovation an opportunity or a threat to employment? An empirical analysis of three main industrialized areas: the USA, Japan and Europe. *J. Clean. Prod.* **214**, 758–766 (2019).
77. Yau, O. H. et al. Developing a scale for stakeholder orientation. *Eur. J. Market.* **41**(11/12), 1306–1327 (2007).
78. Ofori, E. K., Li, J., Radmehr, R., Zhang, J. & Shayanmehr, S. Environmental consequences of ISO 14001 in European economies amidst structural change and technology innovation: insights from green governance dynamism. *J. Clean. Prod.* **411**, 137301 (2023).
79. Muthuswamy, V. V., & Sudhakar, B. Applications: mediating role of supply chain integration among internal lean practices, enterprise resource practices, green operations practices and operational performance. *Theory Appl.* **6**, 3 (2023).
80. Zhang, J. & Rudnák, I. Evaluation of the factors affecting consumers' purchases of fresh food online from China and Hungary. *Int. J. eBusiness and eGovernment Stud.* **15**(2), 212–230 (2023).
81. Satar, A., Al Musadieq, M. & Hutahayan, B. Enhancing sustainable competitive advantage: the role of dynamic capability and organizational agility in technology and knowledge management: Indonesian stock exchange evidence. *Int. J. Constr. Supply Chain Manage.* **29**(2), 431–457 (2023).
82. Lello, D., Huang, Y., Alananga, S. & Emuze, F. The impact of outbound collaboration behavior on service performance in Tanzania's construction projects: the mediating role of knowledge infusion. *Int. J. Constr. Supply Chain Manage.* **13**(1), 92–111 (2023).
83. Narayanan, S., Jayaraman, V., Luo, Y. & Swaminathan, J. M. The antecedents of process integration in business process outsourcing and its effect on firm performance. *J. Oper. Manage.* **29**(1–2), 3–16 (2011).
84. Bhatti, M. A. & Alawad, W. A. Online reviews and brand reputation management in the digital landscape: exploring moderating role of product type. *Trans. Market. J.* **11**(2), 40–59 (2023).
85. Kanan, M. et al. Impact of total quality management practices on the transformation to entrepreneurial universities in Palestine: the moderating role of innovation. *Oper. Res. Eng. Sci. Theory Appl.* **6**(3), 34–56 (2023).
86. Baron, R. M. & Kenny, D. A. The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J. Person. Soc. Psychol.* **51**(6), 1173 (1986).
87. Preacher, K. J. & Hayes, F. A. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav. Res. Methods* **40**(3), 879–891 (2008).



88. Krauss, S. I., Frese, M., Friedrich, C. & Unger, J. M. Entrepreneurial orientation: a psychological model of success among southern African small business owners. *Eur. J. Work Organ. Psychol.* **14**(3), 315–344 (2005).
89. Zahra, S. A. & Covin, J. G. Contextual influences on the corporate entrepreneurship-performance relationship: a longitudinal analysis. *J. Business Venturing* **10**(1), 43–58 (1995).
90. Covin, J. A conceptual model of entrepreneurship as firm behavior. *Entrepreneurship Theory Practice* **16**(1), 7–26 (1991).
91. Lumpkin, G. T. & Dess, G. G. Clarifying the entrepreneurial orientation construct and linking it to performance. *Acad. Manage. Rev.* **21**(1), 135–172 (1996).
92. Wiklund, J. & Shepherd, D. Entrepreneurial orientation and small business performance: a configurational approach. *J. Business Venturing* **20**(1), 71–91 (2005).
93. Alonso-Muñoz, S., González-Sánchez, R., Siligardi, C. & García-Muñiña, F. E. New circular networks in resilient supply chains: an external capital perspective. *Sustainability* **13**(1), 6130 (2021).
94. Quintana-García, C., Marchante-Lara, M. & Benavides-Chicón, C. G. Towards sustainable development: environmental innovation, cleaner production performance, and reputation. *Corporate Soc. Responsib. Environ. Manage.* **29**(5), 1330–1340 (2022).
95. Zhang, K. M. & Wen, Z. G. Review and challenges of policies of environmental protection and sustainable development in China. *J. Environ. Manage.* **88**(4), 1249–1261 (2008).
96. Shi, X., Qian, Y. & Dong, C. Economic and environmental performance of fashion supply chain: the joint effect of power structure and sustainable investment. *Sustainability* **9**(6), 961 (2017).
97. Osei, C. D. & Zhuang, J. Rural poverty alleviation strategies and social capital link: the mediation role of women entrepreneurship and social innovation. *Sage Open* **10**(2), 2158244020925504 (2020).
98. Pullman, M. E., Maloni, M. J. & Carter, C. R. Food for thought: social versus environmental sustainability practices and performance outcomes. *J. Supply Chain Manage.* **45**(4), 38–54 (2009).
99. Song, W. & Yu, H. Green innovation strategy and green innovation: the roles of green creativity and green organizational identity. *Corporate Soc. Responsib. Environ. Manage.* **25**(2), 135–150 (2018).
100. Bossle, M. B., de Barcellos, M. D., Vieira, L. M. & Sauvée, L. The drivers for adoption of eco-innovation. *J. Clean. Prod.* **113**, 861–872 (2016).
101. Li, Y. Environmental innovation practices and performance: moderating effect of resource commitment. *J. Clean. Prod.* **66**, 450–458 (2014).
102. Roscoe, S., Cousins, P. D. & Lamming, R. C. Developing eco-innovations: a three-stage typology of supply networks. *J. Clean. Prod.* **112**, 1948–1959 (2016).
103. Kong, T., Feng, T. & Ye, C. Advanced manufacturing technologies and green innovation: the role of internal environmental collaboration. *Sustainability* **8**(10), 1056 (2016).
104. Anwar, S. U. et al. The resilient economic impact of CPEC and future of MNCs: evidence from Pakistan. *Front. Environ. Sci.* **10**, 1161 (2022).
105. Anwar, S. U. et al. Nexus among the perceived infrastructural, social, economic, and environmental impact of CPEC: a case of Pakistan. *Heliyon* (2024).
106. Chen, Y. S. & Chang, C. H. The determinants of green product development performance: green dynamic capabilities, green transformational leadership, and green creativity. *J. Business Ethics* **116**, 107–119 (2013).
107. Xue, M., Boadu, F. & Xie, Y. The penetration of green innovation on firm performance: effects of absorptive capacity and managerial environmental concern. *Sustainability* **11**(9), 2455 (2019).
108. Habib, M. A. et al. Impact of strategic orientations on the implementation of green supply chain management practices and sustainable firm performance. *Sustainability* **13**(1), 340 (2021).

## Author contributions

Syed Umair Anwar: Conceptualization, Writing-Original Draft, Methodology, Data Curation, Software, Validation, and Formal Analysis. Peng Zhi Yuan & Jingru Xu: Supervision, Resources, and Project Administration. Shafique Ur Rehman: Formal Analysis, Review, and Editing. Mariam Hameed: Visualization, Resources. Kaiwen Su; Mei Wen & Feng Zou Li: Visualization and Review.

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## Consent for publication

All authors have agreed to publish the manuscript.

## Ethical approval and consent to participate

The Ethical Review Committee of Southwest Forestry University, School of Economics and Management Science Cert/ES56783455, code/2023J089, 2023/10 approved the study questionnaires. Informed consent was obtained from all the study participants prior to engaging in the study, and their identity was kept anonymous.

## Additional information

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