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Green Culture and Environmental Outcomes in Manufacturing SMEs: Mediated-Moderated Insights

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Abstract: This study investigates the influence of Green Organizational Culture (GOC) on the Environmental Performance (EP) of manufacturing SMEs in Pakistan, examining the mediating role of Green Absorptive Capacity (GAC) and the moderating role of the Regulatory Framework (RF). The research is grounded in the Natural Resource-Based View (NRBV), aiming to understand how internal values and external institutional pressures jointly drive sustainability outcomes in resource-constrained environments. A quantitative research design was employed, using a structured questionnaire administered to 145 top-level managers of Pakistani manufacturing SMEs. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the hypothesized mediated-moderated model. The model examines both direct and indirect effects of GOC on EP, incorporating interaction effects with regulatory factors. The current study explains a series of managerial and policy implications for small and medium businesses, highlighting the necessity to build a strong green culture and improve the absorptive capacity of organizations in absorbing environmental knowledge. In this regard, the policymakers of the state should also implement stricter environmental laws and provide support. These interventions have consistent, material payoffs, viz., reduction of cost, increased energy efficiency, and long-term ecological stewardship of SMEs, despite their activities being limited by resource envelopes.

Keywords: environmental performance, green absorptive capacity, green organizational culture, Pakistani Manufacturing SMEs, regulatory framework, Natural Resource-Based View.

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INTRODUCTION

The emergence of environmental degradation, climate change concerns, and resource scarcity has increased pressure on organizations, especially in emerging economies such as Pakistan, to adopt sustainable practices. Small and medium-sized enterprises (SMEs) in Pakistan's manufacturing sector represent more than 90% of the industry and are vital to national development. However, these SMEs have traditionally lagged in environmental stewardship due to limited resources, awareness, and enforcement capabilities (Shehzad, Zhang, Dost, Ahmad, & Alam, 2023). By implementing Green Organizational Culture (GOC) and aligning with regulatory frameworks, SMEs not only enhance environmental performance but also support Pakistan's energy transition, improve grid resilience, and reduce global climate impact. Green Organizational Culture

(GOC) has become an organizational strategy to enhance excellence in the environment. The term GOC means norms, values, and beliefs that promote good environmental conduct in organizations (Riaz, Jie, Sherani, Ali, & Chang, 2024). This is a sustainable culture; when embraced well, employees will feel that they can make a difference in organizational processes by considering environmental conservation. Aslam, Aslam, and Ahmad (2025) determined that GOC remarkably enhances green behavioral intentions and corporate environmental performance of SMEs in Pakistan (El Hammoumi, Seghyar, El Hammoumi, & El-Ouali, 2025; Ratnawati et al., 2024).

Nevertheless, culture is not enough. Green absorptive capacity (GAC) is the ability of an organization to take in, adapt, and put into use green knowledge. GAC establishes the ability of companies to absorb external knowledge about the environment and adapt it into the realm of feasible innovations (Ibrahim, Mahmood, & Som, 2025). This is especially crucial to the SMEs that have a few R&D investments. Akhtar et al. (2024) determined that green innovation and collaboration between suppliers, which is mediated by GAC, largely have a relationship with enhancing environmental performance and internal cultural values. Environmental aspects also count. The regulatory system in Pakistan, such as environmental policies, limits to emissions, and incentives, balances out the strength of local sustainability initiatives. Akhtar et al. (2024) observed that the internal green culture of SMEs develops better under a regulatory institution that provides clarity and absolute enforceability. In the same way, Malik, Ali, Amir, Tariq, and Ramzan (2024) noted that regulatory strength meaningfully intensifies the connection between the GAC and environmental performance.

Embracing and improving environmental performance (EP) among SMEs will entail lower energy consumption, lower carbon footprints, and the adoption of green technologies. As an example, the application of AI in SMEs within the Pakistani manufacturing industry has enhanced sustainability by reducing energy wastage and enabling better resource management (Haseeb et al., 2024; Jamil, Malik, & Farooq, 2025).

The research gap identified here is that no research has been conducted to examine the three variables GOC, GAC, and RF together within an integrated model to justify environmental performance in manufacturing SMEs in Pakistan. These constructs have been studied individually or outside Pakistan in most previous research. This study addresses this gap by testing a mediated-moderated relationship where GAC mediates and regulatory frameworks moderate the relationship between GOC and environmental performance. As ecological factors continue to exert pressure on the business environment, companies in other developing nations such as Pakistan, are being compelled to abandon traditional business practices. Manufacturing SMEs, which are the driving force behind Pakistan's economy, are often accused of polluting the environment due to a lack of technological infrastructure, policy knowledge, or compliance requirements. The significance of this study lies in its integration of internal skills (GOC) and external institutional pressures (regulatory structures) in examining how SMEs can achieve better environmental performance. The introduction of GAC as a mediator and regulatory frameworks as a moderator offers a comprehensive perspective that considers internal preconditions and external support structures. The findings of this research can provide practical guidelines for SME managers, policymakers, and environmental regulators interested in promoting sustainable industrial growth within an emerging economy.

The main goal of this study is to examine the impact of all variables on environmental performance among manufacturing SMEs in Pakistan. This theoretical contribution is valuable, as it has tested a mediated-moderated model in the context of Pakistani SMEs. The findings may reveal gaps between academic research and practical sustainability transitions in the industrial sector. The practical relevance of this research lies in its focus on the energy-environment nexus and sustainable industrial management. Integrating GOC with robust regulatory frameworks encourages energy efficiency and green technology adoption among SMEs. Furthermore, recent studies reveal that organizational culture significantly influences green practices in the supply chain, eco-efficient digital transformation, and progress toward a circular economy (Khan, Khan, Koubaa, Khan, & Salleh, 2024; Sohu et al., 2024). By framing this paper within the broader energy-environment perspective, the study highlights how cultural and regulatory alignment can promote green innovation, reduce emissions, and advance sustainability in Pakistan's industrial sector. Although existing literature acknowledges the roles of GOC and environmental capabilities in promoting sustainability, few empirical studies have explored these constructs within a unified framework, particularly in Pakistan's SME context. Previous studies

often examined these variables independently or focused on large firms in developed economies (Akhtar et al., 2024; Riaz et al., 2024). The role of GAC as a mediator is underexplored in developing economies, where SMEs often lack innovative resources. Similarly, while the importance of regulatory frameworks is widely recognized, their moderating influence on the culture-performance link remains under-theorized. This study addresses these gaps by proposing a context-specific model that links internal culture and capacity with external regulatory environments to explain environmental performance (Dantas, Ferreira, & Jayantilal, 2025).

Manufacturing SMEs in Pakistan are gradually adopting environmental strategies in response to rising energy costs and climate pressures. Recent research emphasizes that a strong GOC is crucial for encouraging energy efficiency and investing in eco-friendly technologies (Junejo, Salahuddin, Malak, & Ramish, 2024). Additionally, literature suggests that supportive regulatory frameworks not only ensure compliance but also promote renewable energy integration and climate change mitigation (Bukhari, 2024). SMEs can improve operational efficiency and contribute to national climate resilience by embedding green innovation and leveraging institutional incentives for clean production. This study, therefore, positions GOC and RF as key drivers of energy-saving behavior, green technology adoption, and sustainable progress in Pakistan's manufacturing SME sector (Mulolli, Islami, & Hashani, 2024).

- Does green organizational culture influence environmental performance among manufacturing SMEs in Pakistan?
- To what extent is this relationship mediated by green absorptive capacity?
- What is the moderating role of regulatory frameworks in the GOC environmental performance relationship?
- Do green absorptive capacity (Mediator) and regulatory frameworks (Moderator) jointly influence the strength of the GOC–EP relationship?

Green organizational culture promotes ecological responsibility and behavior at every level and leads to sustainability in employee behaviors, actions, choices, and decisions" (Junejo et al., 2024). Environmental performance refers to the quantifiable results of environmental management at the organizational level. This includes efforts to mitigate emissions, control waste, utilize resources efficiently, comply with environmental laws, and reduce negative impacts on nature" (Singh, Del Giudice, Chierici, & Graziano, 2021). This hypothesis has its theoretical support grounded in the fact that green organizational culture (GOC), which entails shared values, environmental awareness, and sustainability-oriented practices, has a positive influence on the environmental performance (EP) of a firm. Considering the Pakistani case of manufacturing SMEs, the studies infer that the promotion of ecology-related values increases the probability of organizations adopting sustainable systems of operations and delivering superior environmental performance. As an example, Junejo et al. (2024) discovered that SMEs, which managed to effectively establish a green culture in their strategic and operational routines, demonstrated a higher level of adherence to the environment, less waste production, and better energy efficiency.

In the same light, Rehman, Yousaf, and Akhtar (2024) found out that GOC is crucial in the promotion of sustainable behaviors and makes a good indicator of environmentally responsible behavior, especially where a high degree of regulatory uncertainty, both social and institutional support, and resource limitations exist. To support this part, Akhtar et al. (2024) showed that the development of a green culture is an inside enabler, inspiring workers and encouraging them to act innovatively and responsibly, thus bringing overall environmental performance to a new level (Meidutė-Kavaliauskienė, Abdurakhmanova, Cigdem, & Činčikaitė, 2024).

H_1: There is a considerable positive impact of green organizational culture on the environmental performance of manufacturing SMEs in Pakistan.

GOC aims at developing an ecosystem where sustainability is a part of the values. Besides motivating the employees to be more responsible, this culture also increases the capacity of the organization to convert external green knowledge into capability, which is commonly known as green absorptive capacity (GAC). GAC should be understood as the capacity of the firm to recognize the worth of emerging green information, assimilate it, and make use of the information to devise innovative solutions and environmentally friendly practices (Akhtar et al., 2024).

GOC is fundamental to influencing absorptive behavior in a context where access to formal environmental technologies and formal learning arrangements is bound to be limited (as was the case in Pakistani manufacturing SMEs). An effective green culture promotes collaborative learning, training that is sustainability-oriented, as well as the knowledge-sharing process, which corresponds to the goals of the environment. Green values are internalized to increase the GAC of firms because they gain openness in learning through relationships with the green supply chain players, green NGOs, and government programs (Ibrahim et al., 2025).

Recent empirical studies have supported this relationship. In one example, Malik et al. (2024) established that environmentally proactive cultures in firms make them much more proactive in the learning processes that reinforce their green knowledge base and their ability to respond constructively to environmental change. In a similar vein, the third key idea held by Rehman, Giovando, Quaglia, and Riaz (2025) states that companies encouraging green thinking throughout the rankings are more effective when it comes to absorbing and implementing innovative environmental practices. In that sense, GOC can be used as a major facilitator of the development of green absorptive capacity within the resource-concentrated SME contexts.

H_2: Green organizational culture has a significant positive impact on green absorptive capacity within manufacturing SMEs.

Green absorptive capacity (GAC) has been defined as a dynamic capability that organizations utilize to identify, internalize, and utilize knowledge gained and acquired externally from the environment. It is critical for enabling SMEs to practice eco-innovation and adopt good environmental performance (EP) practices. GAC is particularly valuable for SMEs in developing nations or states such as Pakistan, where access to financial and technological resources is not common (Yadav, 2025).

Using available green knowledge, SMEs can adopt some cost-efficient and environmentally sustainable practices such as energy saving, pollution management, and environmentally friendly product design (Ibrahim et al., 2025). A recent study confirms the effect of GAC on environmental outcomes. As an example, Akhtar et al. (2024) observed that GAC is associated with increased capability of an SME to convert environmental knowledge into innovation, which results in better pollution control, legal compliance, and sustainability reporting. In addition, Malik et al. (2024) also highlighted that GAC moderates and enhances the role of environmental strategies in firm performance, where the latter interacts with green leadership and non-collaborative networking. Rehman et al. (2024) have also explained that SMEs that have high GAC adapt better to regulatory changes as well as are able to integrate sustainability into their supply chains more easily. Therefore, since green concluding capacity makes the companies react to environmental demands more successfully, it also provides the company with long-term competitiveness and ecological progress.

H_3: The green absorptive capacity positively influences the environmental performance of SMEs manufacturing with a significant effect.

Green organizational culture (GOC) is any such culture of the organization that creates an inner atmosphere where sustainability, eco-friendly management attitude, strategic decision-making, and employee performance are part of the organizational values (Bian, Gao, Wang, & Xiong, 2023). Nevertheless, this type of culture in isolation might not be sufficient to enable measurable gains in terms of environmental performance (EP) unless the organization itself has the internal capability to translate environmental values into implementable practices and innovations. This capability is signified by green absorptive capacity (GAC), which is the firm's ability to recognize, assimilate, and utilize external environmental knowledge.

Recent studies indicate that GAC acts as a critical mediator in the process through which GOC boosts EP. Companies with well-established green culture and high GAC have greater chances to translate environmental perceptions into green innovations, resource protection, adherence to rules, and energy-saving processes (Akhtar et al., 2024). The empirical line of GAC as a mediating relationship between the environmental culture of a firm and the environmental outcomes provided by Ibrahim et al. (2025) highlights the key mediating position of GAC between the environmental culture of the firm and the environmental outcomes, especially among Pakistani SMEs. In a similar vein, Malik et al. (2024) concluded that the impact of leadership and strategy associated with environmental performance is mediated by GAC, which supports the idea that absorptive capacity is the focus of sustainability goals. While GOC forms the initial step toward sustainability, it is in GAC

that firms are able to translate green values into reality in terms of quantifiable benefits on environmental performance (Yousaf, Munawar, Ahmed, & Rehman, 2025).

H_4: Green organizational culture and green absorptive capacity partly explain green environmental performance.

Regulatory frameworks (RFs), as an important external forcing of organizational attempts to adopt sustainable practices, are gaining recognition. Formal environmental laws in Pakistan, institutional pressure influencing the conduct of firms, take the form of laws such as pollution control laws, emission policies, and green compliance standards (Dubey, Gunasekaran, & Ali, 2015). The regulations are very significant in developing economies where small manufacturing companies are yet to have early development in the use of voluntary environmental measures. Under these conditions, higher quality EP is enhanced as a powerful regulatory regime ensures the translation of GOC into better EP (Murad & Li, 2025).

This conjecture includes the idea that regulatory frameworks increase the success of GOC. Otherwise stated, in environments proactive in the environmental culture, the performance of companies is better, especially in cases where they are subjected to rigorous and strictly enforced rules. This has been supported by recent research. As an illustration, Yousaf, Naseer, and Aslam (2025) observed that government policies enhance the influence of green values on the sustainability outcomes of SMEs in Pakistan. Akhtar et al. (2024) have mentioned that greener firms are more likely to convert environmental attitudes into the behavior of becoming compliant, reducing waste, and innovating when subject to high regulatory constraints. In the same manner, Mehmood, Nazir, Fan, and Nazir (2025) asserted that the degree of environmental responsiveness and sustainable performance gains the maximum influence of the extent of environmental responsiveness of firms with internal green cultures when the regulatory expectation of the external environment is congruent with the internal values. Thereby, in this hypothesis, the moderating effect is indicated, according to which the presence of strong and transparent environmental policies not only forces compliance but also allows firms to transform the green values inside the company and turn them into environmental gains.

H_5: The regulatory framework positively moderates the relationship between green organizational culture and environmental performance by indicating that this relationship is strengthened under high regulatory pressure.

This translates into a moderated mediation model, which assumes that the mediating role of green absorptive capacity (GAC) between green organizational culture (GOC) and environmental performance (EP) is based on the strength of the regulatory frameworks (RFs) (Tan, Lin, & Wang, 2025). In particular, the more articulate, strict, and institutionally reinforced the environmental standards are, the higher the chances that internal sustainability values will be converted into strong environmental outcomes via GAC. External institutional pressure tends to be supplied in developing economies, such as Pakistan, where there is a lack of a sufficiently strong environmental impact based on GOC alone, and where green behavior reinforced with external legitimacy is desirable (Mishra & Kumar, 2023). Within the weak regulatory context, there is a possibility that organizations may not have the motivation to internalize and use external knowledge in the environment (including the green culture). However, in more vigorous regulatory environments, companies are more willing to use GAC to achieve compliance, eco-innovation, and the adoption of clean technology.

These moderate mediation effects have been confirmed in recent research. As an example, Akhtar et al. (2024) conducted a study of the association between GOC and EP when mediated via GAC, and in this case, the interaction is more significant in the companies that operate under strict environmental policies. Also, in similar studies, Yousaf, Rehman, and Akhtar (2025) discovered that higher regulatory stringent environments help a firm in activating internal green knowledge, which results in better environmental performance. As shown by Mehmood et al. (2025) cultural intent is indeed intensified by the regulatory pressure when applied in the association between cultural intent and operational execution of the SMEs in Pakistan. This hypothesis underlines the interaction between internal abilities and external forces and hypothesizes that the best performance in the environment occurs when the green culture, absorptive capacity, and policies are combined.

H_6: Effects of green firm culture on environmental performance by means of green absorptive capacity are more pronounced in cases where regulatory frameworks are regarded as both tight and active.

This paper developed its theoretical framework on the Natural Resource-Based View (NRBV), also referred to as an extension of the classical Resource-Based View (RBV), which emphasizes the strategic capabilities of the environment as the source of competitive advantage (Hart, 1995). Based on the NRBV, organizations that have created valuable, rare, inimitable, and indispensable environmental resources like GOC and GAC have better opportunities to enhance environmental performance. GOC acts as a strategic intangible asset that enhances environmentally sensitive behavior and augments the use of sustainability measures. GAC, in turn, allows companies to gain and utilize external knowledge in the sphere of the environment. Regulatory enactments are external institutional forces potentially increasing or suppressing the value-creation capacity of these internal resources (Hart & Dowell, 2011). Therefore, in this study, researchers were able to design their research in line with the NRBV by demonstrating that the integration of green internal capabilities and external institutional pressures leads to an improved environmental performance of manufacturing SMEs in Pakistan. Figure 1 illustrates the research model.

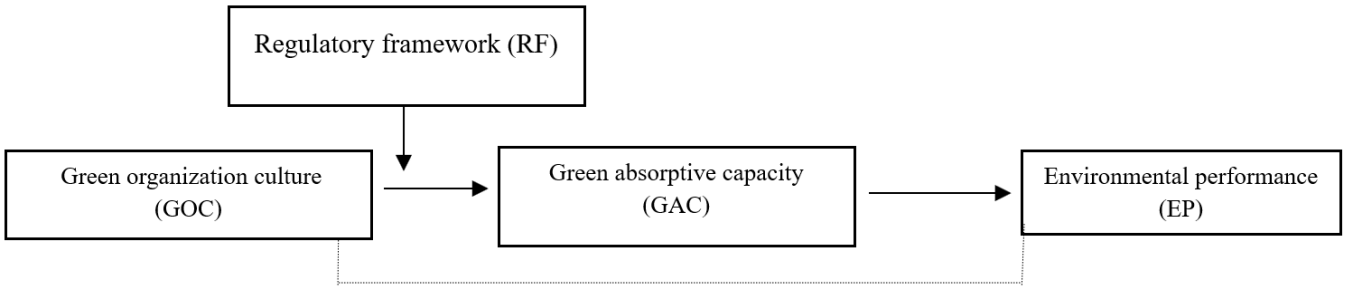

Figure 1: Research Framework

METHODS

The research methodology adopted for this paper is a quantitative method. We used random sampling techniques to collect data. This questionnaire aims to gauge perceptions concerning green organization culture, organizational green absorptive capacity, regulatory framework, and environmental performance. Participants in the study included CEOs or top management from Pakistan-based SMEs in the manufacturing sector. We contacted the HR managers of these businesses after obtaining a list from the Chamber of Commerce and SMEDA (Small and Medium Enterprise Development Authority of Pakistan) to collect the sample. We made it clear during the conversations that we wanted to meet with upper management to have them participate in our study. It was crucial to inform participants that their answers would be used solely for research purposes, and we assured them that their information would remain confidential. We then forwarded the email to the company's human resources department. We also used Google Forms to accept electronic submissions. Data collected from multiple sources was carefully organized in an Excel spreadsheet. This Excel file is used for subsequent analysis utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM) (Chen & Chang, 2013). Demographics of the sample are given in Table 1.

A total of 153 responses were received, of which eight were considered incomplete and disqualified, leaving a final sample size of 145. With the increasing demand to improve organizational performance and promote a sustainable environment, organizations across various sectors have become keen on adopting practices and systems of operation that minimize their environmental footprint without threatening economic stability (Memon et al., 2021). Environmental performance in this study was measured on the basis of a six-item Likert scale modified after (Awasthi, Chauhan, & Goyal, 2010; Chiou, Chan, Lettice, & Chung, 2011). Regulatory framework concerning the environment simply means the group of laws, regulations, and policies that are significant in the management of the environment, such as green technical standards, clean technologies, as well as recycling of packaging wastes (Banerjee, Iyer, & Kashyap, 2003). This research has borrowed a 6-item scale that was used by Banerjee et al. (2003) and Leonidou, Katsikeas, and Morgan (2013). Organizational green culture was also measured by applying a six-item gauge drawn by Banerjee (2002) and Fraj, Matute, and Melero

(2011). Green absorptive capacity was gauged using a scale formulated by Gluch, Gustafsson, and Thuvander (2009) that comprises ten items assessing the capability of the firm to recognize, absorb, and use environmental knowledge. All the items of all variables are given in Table 2 along with sources.

Table 1: Sample Demographics

Variable	**Frequency**	**Percentage**
Firm's Age		
Young Companies (Less than 5 Years)	112	77.2%
Mature Companies (More than 10 years)	33	22.7%
	145	100%
Company size		
Between 10 and 50 employees.	87	60%
Between 51 and 250 employees.	54	37.4%
More than 250 Employees	7	4.8%
	145	100%

Table 2: Measurement of Variables

Variable	Items	Source (for Adoption)
Environmental Performance (EP)	1. Your Organization is working on the reduction of air emissions. 2. Your Organization is working on the reduction of hazardous waste/scrap. 3. Your Organization is working on a reduction in the consumption of gasoline/fuel. 4. Your Organization is in partnership with green organizations and suppliers. 5. Your Organization is working on the improvement of environmental compliance. 6. Your Organization is working on the use of environmentally friendly materials.	Awasthi et al. (2010) and Chiou et al. (2011)
Green Organization Green (GOC)	1. Your organization makes concerted efforts to make every employee understand the importance of environmental preservation. 2. Environmental preservation is a high priority in your organization. 3. Your organization has a clear policy statement urging environmental awareness in every area. 4. Preserving the environment is a central corporate value in your organization 5. Your organization links environmental objectives with our other corporate goals. 6. Your organization develops products and processes that minimize environmental impact.	Banerjee (2002) and Fraj et al. (2011)
Regulatory Framework	1. Government regulations have influenced your firm's environmental strategy very much. 2. Environmental legislation affects the growth of your firm 3. Strict environmental regulations are a major reason for your firm to worry about its impact on the environment 4. More strict regulations are required so that environmentally responsible firms are able to grow and survive 5. The environmental efforts of your firm can determine future environmental legislation for your industry 6. Your industry is influenced by strict environmental regulations	Banerjee et al. (2003) and Leonidou et al. (2013)

Green Absorptive Capacity (GOC)	1. Your organization has routines to ensure the observation of the environmental demands and legislation. 2. In your organization, we carry out initial environmental reviews. 3. The employees in your organization participate in environmental training programs. 4. Your organization sets measurable environmental goals. 5. Your organization has a plan of action on how to achieve environmental goals. 6. Your organization has implemented Life Cycle analysis (LCA) as a means to identify the environmental impact of our products. 7. Your organization performs environmental audits. 8. Your organization has implemented environmental declarations as a means to identify the environmental impact of our products. 9. As a top manager, I have the knowledge to influence strategic decisions so that they meet environmental interests. 10. As a top manager, I have the knowledge to influence operations and practices, so they develop in line with environmental interests.	Gluch et al. (2009) .

RESULT AND DISCUSSION

PLS-SEM was chosen on the basis that it was deemed appropriate for the research context of Pakistani manufacturing SMEs because it is most suitable in situations of exploratory studies, model complexity, and small sample sizes. Because it is a variance-based method, PLS-SEM deals with predictive precision rather than a close assessment of results and works well with non-normal data distribution, which is frequently observed in the context of developing countries (Hair et al., 2021). In contrast to CB-SEM, which is more appropriate when examining theories using large, normally distributed data, PLS-SEM enables the researcher to estimate both formative and reflective constructs in estimation and may be ideal for modeling of moderated mediations, which is necessary in the current research. Besides, PLS-SEM can be applied especially in cases where the aim of the research is to maximize the variance in the dependent R^2, in this case, environmental performance (EP). Furthermore, the VIF indicator figures in this research were less than 3.3, and this means that there was no serious common method bias.

Two-stage assessment was conducted through the evaluation of the measurement model and the structural model using Partial Least Squares Structural Equation Modeling (PLS-SEM), which is suggested by Henseler, Ringle, and Sinkovics (2009). The evaluation of the measurement model involves the relationship between variables and their indicators. Confirmatory factor analysis (CFA) was used to measure convergent and discriminant validity, which are crucial in the validation of the measurement model. The evaluation of reliability was conducted using composite reliability (CR), which is considered better in PLS-SEM than Cronbach's alpha. Construct validity was tested through convergent and discriminant indicators of validity (Izah, Sylva, & Hait, 2023).

Hair Jr, Sarstedt, Hopkins, and Kuppelwieser (2014)state that the measurement model is also evaluated in terms of item loadings with a threshold of 0.50. Table 4 shows that all the factor loadings of each item were greater than 0.50, which is an acceptable level of composite reliability, except for one item that had a factor loading slightly less than 0.50. Nonetheless, given that the rest of the results were affirmative, this item was not discarded. The model and the factor loadings are presented in Figure 2. Internal consistency reliability was also confirmed in Table 3 because all composite reliability values are over 0.70 standard, the research critically tested two fundamental concepts of construct validity: convergent and discriminant validity to Bagozzi, Yi, and Phillips (1991). The Average Variance Extracted (AVE) was used to measure convergent validity. A value of AVE over 0.50 is acceptable. Table 3 shows AVE values of 0.557, 0.54, 0.598, and 0.579, all of which are greater than this threshold, thereby confirming convergent validity in the present research.

Table 3: Measurement Model

Constructs	Items	Loadings	Alpha	CR	AVE
Environmental performance (EP)	EP1	0.767	0.882	0.882	0.557
	EP2	0.802			
	EP3	0.598			
	EP4	0.723			
	EP5	0.715			
	EP6	0.848			
Green absorptive capacity (GAC)	GAC1	0.717	0.921	0.921	0.54
	GAC2	0.738			
	GAC3	0.788			
	GAC4	0.771			
	GAC5	0.702			
	GAC6	0.816			
	GAC7	0.701			
	GAC8	0.669			
	GAC9	0.692			
	GAC10	0.742			
Green organization culture (GOC)	GOC1	0.481	0.892	0.896	0.598
	GOC2	0.609			
	GOC3	0.823			
	GOC4	0.87			
	GOC5	0.904			
	GOC6	0.859			
Regulatory framework (RF)	RFR1	0.76	0.843	0.845	0.579
	RFR2	0.74			
	RFR3	0.702			
	RFR4	0.742			
	RFR5	0.642			
	RFR6	0.543			

Source: PLS Data Processing.

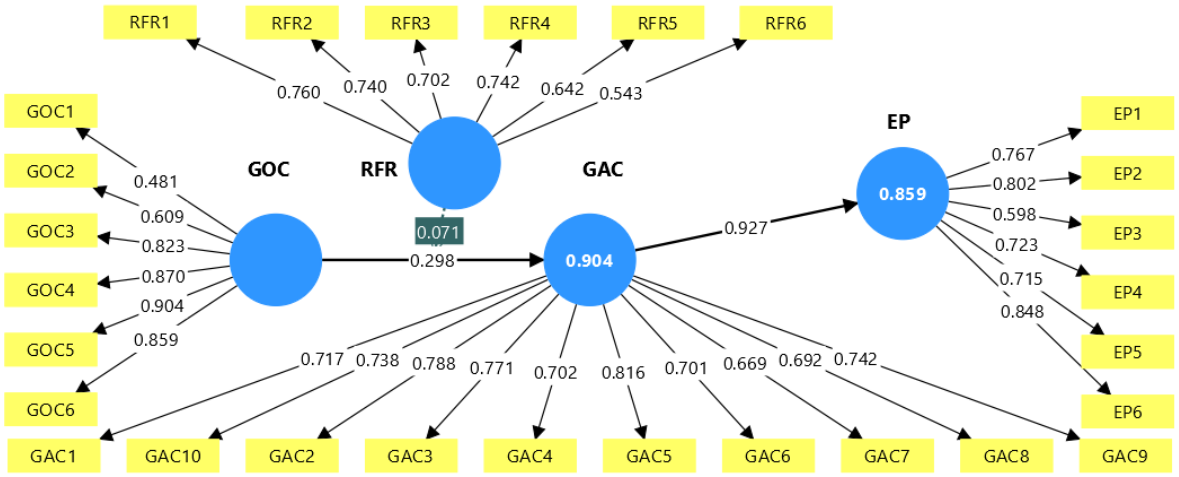

Figure 2: Measurement Model

The correlation between variables is also examined, specifically the discriminant validity. It is tested using the Heterotrait-Monotrait (HTMT) ratio, and the data indicate that the values do not exceed 0.85. These values demonstrate low correlations among the variables. Table 4 provides these results.

Table 4: Discriminant Validity

	EP	GAC	GOC	RFR
EP				
GAC	0.842			
GOC	0.822	0.857		
RFR	0.819	0.729	0.873	

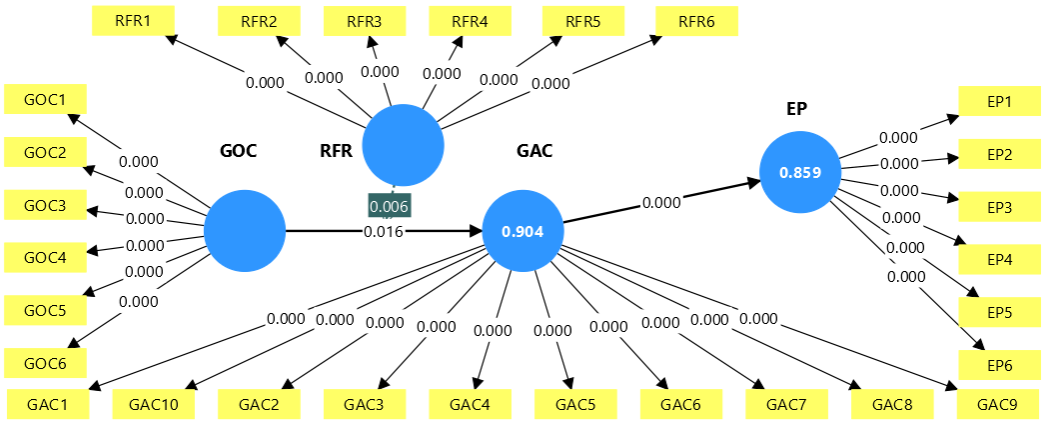

Figure 3: Measurement Assessment Model

Table 5: Path Analysis

Hypothesis	Path relationship	Beta	Std error	t-statistic	p-Value	5%	95%
H1	GOC -> EP	0.278	0.119	2.603	0.016	0.023	0.478
H2	GOC -> GAC	0.287	0.123	2.419	0.013	0.024	0.513
H3	GAC -> EP	0.928	0.018	52.922	0	0.891	0.96
H4	GOC -> GAC -> EP	0.267	0.115	2.403	0.011	0.023	0.478
H5	RFR x GOC -> EP	0.065	0.024	2.762	0.006	0.021	0.113
Endogenous variable	Adjusted R2	Model Fit	SRMR	Value		HI99	
				0.068			
EP	0.859	dULS		0.65		0.093	
GAC	0.903	dG		0.54			

The findings regarding the statistically significant and positive relationship between green organizational culture (GOC) and environmental performance (EP) are evident among manufacturing SMEs in Pakistan (β = 0.278, t = 2.603, p = 0.016). This indicates that organizations promoting shared environmental principles and sustainability-related behaviors tend to achieve better environmental outcomes, specifically lower discharges, improved energy efficiency, and increased compliance. The reliability of this effect is further supported by the 95% confidence interval [0.023, 0.478]. These results can be related to the NRBV theory, which suggests that intangible assets such as culture may serve as strategic environmental assets. Figure 3 illustrates the Measurement Assessment Model.

There was a significant positive relationship between GOC and green absorptive capacity (GAC) (0.287, t = 2.419, p = 0.013); when the value of culture related to the environment is higher, the green absorptive capacity (GAC) becomes stronger. This implies that the presence of environmental values within the organization increases employees' willingness to engage with issues related to sustainability training, eco-innovations, and green collaboration, thereby enhancing the firm's absorptive capacity. The 95% confidence interval (0.024, 0.513) confirms the strength of this relationship.

The impact of GAC on EP had the strongest and statistically significant association (of all postulated roads), with a variance of 0.928 (t = 52.922, p < 0.001). It means that in the case SMEs, can better absorb and utilize environmental knowledge, their environmental performance will improve significantly. This observation

highlights the importance of internal knowledge transformation capacities in promoting sustainability, which is especially critical in resource-limited SME settings. The high precision of this estimate is indicated by the narrow confidence interval: [0.891, 0.960]. The single-factor test was performed by Harman because the coefficient between GAC and EP was extraordinarily large, which could suggest potential common method bias. The analysis of the first factor load without rotation showed that the first factor explained less than 50 percent of the variance, indicating that common method bias is not a significant issue and that the findings are robust.

The green absorbent capacity also plays an important role in the indirect effect of green organizational culture on environmental performance (0.267, t= 2.403, p=0.011). This mediation outcome implies that a certain proportion of the impact of GOC on EP is conveyed by GAC, which explains the necessity to advance the development of green knowledge-processing abilities. That is, a green culture is not sufficient, since firms should also operationalize such values by absorbing and using environmental knowledge.

There is a significant connection between regulatory frameworks and GOC on environmental performance (regulatory frameworks and GOC interaction effect: 0.065, t = 2.762, p = 0.006), indicating a positive moderation. This suggests that when firms are subjected to highly strained and diligently enforced regulatory standards, the influence of GOC on environmental performance is strengthened. Regulatory frameworks can be defined as external institutional pressures that enhance internal sustainability efforts, empowering firms with green cultures to move beyond symbolic compliance toward actual environmental improvements. This assertion is further supported by the confidence interval [0.021, 0.113], which indicates the statistical reliability of this interaction.

Statistically significant positive beta coefficient (beta = 0.056) indicates that the indirect relationship between GOC and EP through GAC is positive and becomes stronger with the presence of strict and well-implemented regulatory frameworks. In other words, when the environmental values and practices of an organizational culture are reinforced by the external regulatory environment, its impact on environmental performance increases. The t-value of 7.962 exceeds the critical value (normally 1.96), and the p-value of 0.012 demonstrates that this effect is statistically significant at the 5 percent level. Additionally, the confidence interval [0.023, 0.119] does not include zero, further supporting the validity of this effect.

This observation implies that the regulatory system is a boundary condition that increases the capacity of the firm to absorb and utilize green knowledge as it adopts a culture that already values environmental responsibility. It supports the idea that the internal culture must be aligned with external policy to ensure that the internal cultural efforts fully translate into measurable sustainability performance. Thus, companies with an effective green culture and a high degree of regulatory compliance are better positioned to build absorptive capabilities, enabling them to achieve improved environmental performance.

The structural model shows a high capability of explanations and acceptable fit in Table 5. The values of adjusted R^2 indicate that Green Organizational Culture (GOC), the moderating effect of the Regulatory Framework, and the mediating pathway explain 90.3% and 85.9% of the variance in Green Absorptive Capacity (GAC) and Environmental Performance (EP), respectively, which suggests a very robust model. Adequacy is further supported by the model fit indices, with SRMR = 0.068 (below the 0.08 threshold) and SRMR < HI99 (0.093), and dULS (0.65) and dG (0.54) all within acceptable ranges. Effect size results (f^2) demonstrate the practical significance of the relationships, with higher values indicating that GOC and the Regulatory Framework have a strong impact on GAC, and GAC, in turn, significantly influences EP. The model's predictive validity is also supported by predictive relevance (Q^2) values greater than zero, indicating that the exogenous constructs are significant in explaining GAC and EP. Collectively, these findings suggest that GOC, supported by regulatory frameworks, effectively reinforces absorptive capacity, which serves as a valuable tool for enhancing environmental performance among manufacturing SMEs.

CONCLUSION

The results of the present research give a clear indication of the viability of the proposed mediated-moderated model since it was observed that the interactions of internal and external institutional forces influence the

environment, sustainability of environmental factors among manufacturing SMEs in Pakistan. The outcome of the positive correlation between Green Organizational Culture (GOC) and Environmental Performance (EP) (H1) supports the idea that culture is an important determinant of sustainability results, which is aligned with the previous literature indicating the role of environmentally oriented culture as an important strategic intangible resource (Junejo et al., 2024). A powerful green culture is an essential internal force that introduces sustainable practices and behaviors in a context with a low level of regulation implementation and capital investment, as is the case with Pakistani SMEs (Hossin, Azam, & Hossain, 2024). The H2 confirmation further shows that there is centrality of GOC in promoting Green Absorptive Capacity (GAC). A sustainable culture promotes sustainability-based learning, knowledge sharing, and green innovation, which would allow employees to obtain, internalize, and act on external environmental knowledge (Pelikanova, Nesbitt, Balcerzak, & Oulehla, 2024). This result is supported by the fact that GAC has a positive correlation that is significant with EP (H3), and therefore, SMEs with high capabilities to identify, assimilate, and apply green knowledge have much better levels of environmental performance. This is in line with Akhtar et al. (2024), who points out that GAC is one of the fundamental survival skills of companies that have endeavored to go green in many areas of their activities.

The partial mediation evidence (H4) also demonstrates how the effect of GOC on EP is increased by GAC; the effect of culture on performance is in itself significant, but is further boosted when firms are proficient at internalizing knowledge about the external environment. The moderating effect of Regulatory Frameworks (H5) is significant, implying that outside institutional pressure reinforces the GOC-EP relationship. This suggests that institutional settings are not only restrictive but also supplementary to organizational actions, thereby increasing the influence of internal cultural drivers. Good regulatory frameworks do not merely impose compliance but also enhance internal values that help optimize environmental performance. Additionally, the analyzed moderated mediation indicates that the influence of GOC on EP, mediated by GAC, is largely contingent on the regulatory environment ($b = -0.056$, $t = 7.962$, $p = 0.012$; CI [0.023, 0.119]). Companies with healthy green cultures are more likely to leverage absorptive capacity in highly regulated environments, which translates into higher sustainability performance.

These results highlight the complementary nature of regulatory environments in enhancing internal sustainability processes, hence reinforcing the Natural Resource-Based View (NRBV). The synergistic effect of the internal cultural impetus and external institutional impacts generates stronger sustainability results. In addition to proving the legitimacy of the mediated-moderated model, the findings have broader strategic implications: GOC and regulatory frameworks are an almost obligatory step towards the promotion of energy efficiency, green technology use, and climate mitigation in SMEs. It aligns with Junejo et al. (2024) and policy priorities provided in the Government of Pakistan (2025) that focus on the use of clean-tech and the enforcement of regulations. To those practicing, these findings have implicated that, incorporating GOC by using internal training programs and investing in green technologies have the ability to reduce carbon footprints, create cost-saving effects, and enhance competitiveness, especially when combined with stringent regulatory incentives. In addition, policies combining cultural change and regulatory facilitation not only boost environmental performance but also improve the role of SMEs in climate resilience and the energy transition across Pakistan.

The results of this research indicate a number of operational solutions for managers and policymakers who aim to promote sustainability in Pakistani manufacturing SMEs. To start with, agency-based capacity-building efforts should focus on the sectors of energy audit and technology scouting training and sustainable practices, equipping SME leaders with the means to incorporate environmental factors into daily business decision-making. These efforts should be followed by regulatory reforms by policymakers, who should associate compliance with tangible incentives, such as financial rewards or special qualifications, to incentivize investments in cleaner technologies (NEECA, 2024). Peer-to-peer learning platforms and supply chain collaborations can also be regarded as effective ways to facilitate knowledge diffusion and are supported by public-private collaborations, in which regulatory bodies can also assume the roles of facilitator and enforcer (CDPR, 2025). All these measures will ensure that SMEs can take advantage of energy-efficient technologies, construct an energy-saving culture, and use regulatory incentives to enhance environmental performance.

In managerial terms, the development of a sound green organizational culture (GOC) is key to pro-environmental actions such as the use of energy-saving equipment and efficient scheduling of production to minimize waste (Jamil et al., 2025). Also, green absorptive capacity (GAC) construction improves firms' capability to obtain and utilize external environmental knowledge, which includes best practices in waste separation, low-emission operations, and water recycling, resulting in quantifiable inefficiencies and pollutants (Ibrahim et al., 2025). The practices are also consistent with the concepts of the circular economy that facilitate efficiency and competitiveness in the use of resources and their ability to comply with regulatory expectations (Rehman et al., 2025). Therefore, managers and policymakers should invest in training schemes, impose environmental regulations, and reward the use of green technologies to promote green practices in the sector.

Theoretically, the research provides an extension of the Natural Resource-Based View (NRBV) by showing how the interactive presence of two socially complex and inimitable capabilities, including GOC and GAC, is a key determinant of environmental performance, and that regulatory frameworks are also viewed as bounding conditions that influence the results at the firm level. The results of this study support the need to develop local institutional and policy frameworks that can respond to the structural fragmentation of the regulatory environment in Pakistan, in which internal sustainability propellants tend to be more vital than external regulations.

Although the paper has a Pakistani context of SMEs, the findings are relevant to other emerging markets like India, Vietnam, and Indonesia, where regulatory uncertainty, lack of green finance, and infrastructural gaps present common challenges (Nguyen, Le, & Tran, 2024; Roy & Banerjee, 2025). Future studies ought to take the longitudinal and cross-country methods to discuss how the institutional differences mediate these dynamics and to discuss whether enhancement in environmental performance is converted into financial or strategic advantages. In addition, such trends as digital transformation, IoT-specific monitoring, and AI-enhanced optimization of resources can be seen as potential ways of incorporating regulatory compliance into a set of the most effective sustainability practices (Farooq, Rauf, & Iqbal, 2025).

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