Journal of Management Science Research Review
https://jmsrr.com/index.php/Journal/about
Volume. 5 Issue No. 1 (2026)
Online ISSN: 3006-2047
Print ISSN: 3006-2039

From Environmental Commitment to Green Innovation: The Mediating Role of Green Absorptive Capacity in SMEs

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Abstract
Environmental sustainability has become a strategic priority for small and medium-sized enterprises (SMEs) facing increasing ecological pressures and competitive demands. However, the mechanism through which environmental commitment translates into green innovation remains insufficiently understood. Grounded in the Natural Resource-Based View and Dynamic Capability Theory, this study examines the direct effect of environmental commitment on green innovation and investigates the mediating role of green absorptive capacity. Data were collected from 535 managerial-level employees of manufacturing SMEs in Khyber Pakhtunkhwa using a structured questionnaire. The hypotheses were tested using Andrew Hayes' PROCESS Macro (Model 4) with bootstrapping to assess direct and indirect effects. The findings reveal that environmental commitment significantly and positively influences green innovation. Moreover, environmental commitment enhances green absorptive capacity, which in turn significantly promotes green innovation. The mediation analysis confirms that green absorptive capacity partially mediates the relationship between environmental commitment and green innovation, highlighting its role as a key transformation mechanism. The results emphasize that strategic environmental orientation alone is insufficient unless supported by knowledge-based capabilities that enable firms to absorb and apply environmental knowledge effectively. This study contributes to sustainability and innovation literature by integrating strategic commitment with capability development in the SME context and provides practical implications for managers and policymakers aiming to strengthen green innovation performance.

Keywords: Environmental Commitment, Green Absorptive Capacity, Green Innovation, Natural Resource-Based View, Dynamic Capability Theory

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Print ISSN: 3006-2039

Introduction

Environmental sustainability has emerged as a central concern in contemporary business environments as firms face increasing ecological pressures, stakeholder expectations, and regulatory demands to minimize environmental harm while maintaining economic competitiveness (Abumalloh et al., 2024; Afridi, Javed, et al., 2023). Green innovation, defined as the development and implementation of products, processes, and managerial systems that reduce environmental impact, has become a strategic imperative for firms seeking long-term viability in sustainability-oriented markets (Abbas, 2024; Agrawal et al., 2024). Especially in small and medium-sized enterprises (SMEs), green innovation represents both a challenge and an opportunity: limited resources and capabilities often constrain innovation initiatives, yet sustainable innovation can unlock competitiveness, market access, and legitimacy (Ahmeda et al., 2020; Al Halbusi et al., 2023)

Within the sustainability literature, environmental commitment has been recognized as a key strategic driver of innovation (Afridi, Asad, et al., 2023; Patwary, 2023). Environmental commitment refers to the degree to which top management values environmental protection, integrates it into strategic planning, and allocates resources to environmental initiatives (Mura et al., 2024; Zhang et al., 2021). In SMEs, where decision-making is frequently centralized in owner-managers, this commitment strongly shapes organizational norms, orientations, and long-term strategic trajectories (Ali et al., 2020; Alojail & Khan, 2023). Firms with stronger environmental commitment are more likely to adopt eco-friendly technologies, redesign products and processes for environmental performance, and invest in environmental learning and stakeholder engagement (Agyabeng-Mensah et al., 2022; Patwary, 2023)

However, strategic intent alone does not fully explain how environmental commitment translates into effective green innovation outcomes. Scholars have argued that while environmental commitment provides motivation and direction, innovation outcomes depend critically on internal capabilities that allow firms to sense, assimilate, and exploit environmental knowledge (Xiao et al., 2023). This is particularly true in SME contexts, where constrained R&D resources make external knowledge acquisition and utilization fundamental for innovation (Figiel & Badar, 2025). Drawing on the Natural Resource-Based View (NRBV) and Dynamic Capability Theory, this study proposes that green absorptive capacity mediates the relationship between environmental commitment and green innovation. Green absorptive capacity is a firm's ability to acquire, assimilate, transform, and apply external environmental knowledge to improve organizational

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Online ISSN: 3006-2047
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processes and products (Akhtar et al., 2024; Alshahrani & Salam, 2024). This knowledge capability enables firms not only to understand external environmental technologies and practices but also to integrate such knowledge effectively into operational activities, thereby enhancing their innovative performance. Prior research indicates that absorptive capacity is positively related to green innovation outcomes, often through mechanisms such as environmental motivation and organizational learning (Hussein et al., 2024; Khraishi et al., 2023; Tufan & Mert, 2023; Zahoor et al., 2024).

From a theoretical perspective, the NRBV posits that firms can sustain competitive advantage by developing resources and capabilities that are valuable, rare, and difficult to imitate. Environmental commitment serves as a strategic resource that prompts investment in environmental learning and knowledge acquisition . Dynamic Capability Theory further suggests that firms with strong knowledge-related capabilities—such as green absorptive capacity—are better equipped to adapt to environmental changes and convert strategic intent into actionable innovation (Xiao et al., 2023).

Although studies have examined various antecedents of green innovation, empirical research on the mediating role of green absorptive capacity in the commitment–innovation relationship remains limited—especially for SMEs in emerging economies. Most existing studies either consider direct effects of environmental strategy on innovation or explore absorptive capacity in isolation rather than as a mechanism linking commitment and innovation. This gap is notable given SMEs' unique resource constraints and reliance on external partnerships, which make absorptive capacity particularly salient for their innovation performance (Malik et al., 2024; Figiel & Badar, 2025).

To address this gap, this study empirically investigates how environmental commitment influences green innovation through the mediating role of green absorptive capacity. By focusing on SMEs, this research contributes to the sustainability innovation literature by advancing an integrative framework that links strategic environmental orientation with knowledge capabilities and innovative outcomes. Specifically, this study offers three theoretical contributions; 1)It clarifies the mechanism through which strategic environmental commitment translates into green innovation.2) It highlights the significance of green absorptive capacity as a dynamic capability that bridges strategic intent and innovation realization, and 3) It extends the NRBV and Dynamic Capability Theory to the SME context in emerging economies, illustrating how internal orientation and external knowledge capability jointly shape sustainable innovation performance.

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Practically, the findings offer actionable insights for policymakers and SME leaders seeking to foster green innovation through internal capability development. Evidence of the mediating role of absorptive capacity suggests that environmental commitment must be complemented by deliberate efforts to enhance knowledge acquisition and utilization, such as through training, external collaborations, and participation in industry networks. By strengthening these capabilities, SMEs can better transform environmental intent into innovative solutions that contribute to environmental sustainability and economic resilience. Through this study, we aim to advance both theoretical understanding and practical strategies for achieving sustainable innovation in SMEs—addressing a critical need in a world where ecological challenges demand responsive, knowledge-driven, and innovation-oriented business strategies.

Literature Review and Hypotheses Development

Environmental Commitment and Green Innovation

Environmental commitment reflects the extent to which top management integrates environmental concerns into strategic priorities, decision-making processes, and resource allocation (Mura et al., 2024; Zhang et al., 2021). It represents a firm-level strategic orientation that signals the importance of sustainability within the organization. In SMEs, where strategic authority is centralized, managerial commitment strongly shapes innovation direction and organizational priorities (Ayadi et al., 2024; Bakos et al., 2020). Whereas green innovation refers to the development or adoption of products and processes that reduce environmental impact, improve resource efficiency, or minimize emissions (Al-Romeedy & El-Sisi, 2024; Al Halbusi et al., 2023). Such innovation requires intentional investments, risk tolerance, and long-term orientation—conditions that are not automatically present in resource-constrained SMEs.

From the NRBV (Hart, 1995), environmental commitment functions as a strategic antecedent to the development of environmental capabilities. Firms that prioritize environmental objectives allocate resources toward pollution prevention, eco-design, and cleaner technologies. These investments build firm-specific environmental competencies that facilitate innovation. Without strategic commitment, environmental initiatives remain symbolic or compliance-driven, limiting their innovative potential. Furthermore, environmental commitment directs managerial attention toward environmental opportunities (Montgomery et al., 2023; Wibowo et al., 2023). According to the attention-based view of the firm, what top managers prioritize determines organizational action. When environmental sustainability becomes a central strategic concern, firms are more likely to

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search for environmentally friendly technologies, collaborate with green stakeholders, and redesign products and processes accordingly.

Empirical research supports this theoretical reasoning. Studies consistently report that top management environmental commitment positively predicts green product innovation and green process innovation, particularly in manufacturing SMEs (see e.g., Abbas, 2024; Al-Romeedy & El-Sisi, 2024; Borah et al., 2023; Chaihanchanchai & Anantachart, 2023). Environmentally committed firms are more likely to adopt eco-design practices, invest in clean technologies, and pursue voluntary environmental initiatives that stimulate innovation. Evidence from emerging economies further shows that managerial environmental orientation strengthens firms' proactive environmental strategies, leading to improved green innovation performance. Importantly, in SMEs, the effect of environmental commitment is amplified due to centralized governance structures and limited bureaucratic inertia. When owner-managers prioritize environmental sustainability, organizational responses tend to be swift and strategically aligned, thereby increasing the likelihood of innovation outcomes. Taken together, both theoretical arguments and empirical evidence suggest that environmental commitment acts as a strategic driver of green innovation in SMEs.

Hypothesis 1:

Environmental commitment positively influences green innovation in SMEs.

Environmental Commitment and Green Absorptive Capacity

In SMEs, where strategic authority is concentrated in owner-managers, environmental commitment strongly influences which domains receive managerial attention, financial investment, and organizational learning efforts (Mura et al., 2024; Ojo & Fauzi, 2020). When environmental sustainability becomes a strategic priority, firms are more likely to engage in systematic environmental scanning, build sustainability-oriented routines, and allocate resources toward environmental capability development. Green absorptive capacity refers to a firm's ability to acquire, assimilate, transform, and apply environmental knowledge for sustainability-related purposes (Hussein et al., 2024; Inayat et al., 2022; Khraishi et al., 2023). It is a specialized form of absorptive capacity focused specifically on environmental technologies, regulatory knowledge, eco-design practices, and green process improvements. Unlike general learning capability, green absorptive capacity requires deliberate efforts to identify relevant environmental information, interpret it effectively, and integrate it into operational processes. Particularly in SMEs—where internal R&D capabilities are often limited—the ability to absorb external environmental knowledge becomes a critical strategic asset.

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Environmental commitment is expected to positively influence green absorptive capacity through several interrelated mechanisms. First, managerial commitment directs organizational attention toward environmental knowledge sources, such as regulatory updates, sustainable technologies, green suppliers, and environmentally conscious customers (Afridi et al., 2020; Afridi et al., 2024; Ibrahim & Hassan, 2025). According to the attention-based logic of strategic management, what top managers prioritize determines what the organization searches for and learns. When sustainability is embedded in strategic intent, firms are more likely to invest in environmental monitoring and knowledge acquisition activities (Afridi et al., 2021; Ibrahim & Khan, 2025).

Second, developing absorptive capacity requires resource allocation for training, knowledge-sharing systems, external collaborations, and experimentation (Afridi, Javed, et al., 2023; Sajid et al., 2025). In resource-constrained SMEs, such investments occur only when leadership explicitly values environmental objectives. Environmental commitment legitimizes these investments and reduces resistance to environmental learning initiatives. Without such commitment, environmental knowledge acquisition may remain fragmented or reactive.

Third, environmental commitment fosters a pro-learning climate around sustainability issues. Organizational learning theory suggests that managerial values shape norms regarding knowledge exchange and experimentation (Afridi et al., 2017; Afridi et al., 2020; Ibrahim & Hussein, 2024). When sustainability is treated as strategically important, employees are more motivated to acquire environmental expertise, share sustainability-related insights, and integrate new knowledge into routines. Over time, these practices accumulate into structured green absorptive capacity.

Empirical research provides emerging support for this relationship. Studies examining sustainability-oriented firms have found that top management environmental commitment significantly enhances environmental learning processes and knowledge integration capabilities (Alshahrani & Salam, 2024; Castillo & Trinh, 2019). Evidence from manufacturing SMEs indicates that firms with stronger environmental orientation engage more actively in external environmental collaborations and demonstrate greater ability to internalize green technologies. Research in emerging economies further shows that managerial environmental commitment strengthens firms' environmental knowledge acquisition and assimilation mechanisms, which are essential precursors to green innovation performance (Ahmed et al., 2024; Al-Filali et al., 2023). These findings suggest that environmental commitment operates not only as a motivational

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driver but also as a foundational antecedent to environmental knowledge capability development.

Theoretically, this relationship is strongly grounded in Dynamic Capability Theory, which posits that firms must build sensing and learning capabilities to respond to environmental changes. Green absorptive capacity represents such a dynamic capability, enabling firms to reconfigure resources in line with sustainability demands. However, dynamic capabilities do not emerge spontaneously; they are cultivated through strategic intent and sustained managerial prioritization. Environmental commitment provides this strategic trigger by directing attention and resources toward environmental learning.

Similarly, the Natural Resource-Based View (NRBV) argues that sustainable competitive advantage arises from the development of valuable and inimitable environmental capabilities. Green absorptive capacity constitutes one such capability, as it allows firms to continuously integrate emerging environmental knowledge into operational and innovation processes. Environmental commitment acts as an antecedent strategic orientation that stimulates the formation and strengthening of this capability. Taken together, both theoretical reasoning and empirical evidence suggest that environmental commitment shapes the development of green absorptive capacity in SMEs by directing attention, legitimizing investments, and fostering sustainability-oriented learning routines.

Hypothesis 2 (H2)

Environmental commitment positively influences green absorptive capacity in SMEs.

The Mediating Role of Green Absorptive Capacity Between Environmental Commitment and Green Innovation

While environmental commitment provides the strategic direction for sustainability-oriented actions and directly enhances green innovation, its influence is not necessarily automatic or direct. Strategic commitment must be translated into operational outcomes through organizational capabilities that enable firms to convert environmental intent into innovation outputs (Afridi, Javed, et al., 2023; Al-Filali et al., 2023; Al-Qahtani et al., 2022). In this context, green absorptive capacity plays a critical mediating role by functioning as the knowledge-based mechanism through which environmental commitment is transformed into green innovation performance.

Environmental commitment strengthens green innovation by first shaping the development of green absorptive capacity (Abbas et al., 2020; Camacho et al., 2025; Carballo-Penela et al., 2020). As discussed earlier, committed firms actively invest in environmental knowledge acquisition,

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learning systems, external collaborations, and sustainability-oriented training (Ameer & Khan, 2020; Arda et al., 2023; Arman et al., 2023). These investments enhance the firm's ability to acquire and assimilate environmental knowledge from external sources and transform it into actionable insights. Without such capability development, environmental commitment may remain symbolic or limited to policy-level statements rather than producing substantive innovation outcomes.

Once green absorptive capacity is developed, it directly facilitates green innovation. Firms with strong absorptive capacity are better positioned to identify technological opportunities related to eco-design, cleaner production systems, renewable energy integration, and waste reduction (Abourokbah et al., 2023; Tufan & Mert, 2023; Zahoor et al., 2024). They can effectively integrate external environmental knowledge into product redesign and process improvement initiatives. Empirical studies indicate that absorptive capacity significantly enhances innovation performance because it enables firms to internalize external knowledge and convert it into tangible innovation outputs. In the sustainability domain, research demonstrates that firms with higher environmental knowledge integration capability exhibit stronger green product innovation and green process innovation performance. Thus, the mediating logic operates through a capability-building mechanism: environmental commitment establishes strategic priority and resource allocation for sustainability, which strengthens green absorptive capacity, and this enhanced capability subsequently drives green innovation. In other words, commitment provides the motivation, while absorptive capacity provides the mechanism for implementation.

Theoretically, this mediation is strongly grounded in the Natural Resource-Based View and Dynamic Capability Theory. From the NRBV perspective, environmental commitment initiates the development of environmentally valuable capabilities that generate competitive advantage. However, competitive advantage emerges only when these capabilities are embedded within organizational routines and translated into innovation outputs. Green absorptive capacity represents such an embedded capability that transforms environmental orientation into innovation performance. Dynamic Capability Theory further supports the mediating mechanism by suggesting that firms must continuously sense environmental opportunities, seize them, and reconfigure resources accordingly. Environmental commitment enhances the sensing phase by focusing attention on sustainability challenges. Green absorptive capacity operationalizes the sensing and seizing process by enabling firms to interpret environmental knowledge and apply it in innovation activities. Therefore, innovation

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outcomes materialize through the capability pathway rather than through commitment alone.

Empirical research also supports this sequential logic. Studies in manufacturing and SME contexts show that strategic environmental orientation improves innovation performance when mediated by learning capabilities and absorptive processes. Evidence indicates that firms with strong environmental commitment achieve higher green innovation performance primarily because they develop stronger environmental knowledge integration capabilities. These findings highlight that capability development is a key transmission mechanism between strategic orientation and innovation outcomes.

Accordingly, it can be argued that green absorptive capacity explains how and why environmental commitment translates into green innovation in SMEs.

Hypothesis 3 (H3):

Green absorptive capacity mediates the relationship between environmental commitment and green innovation in SMEs.

Conceptual Framework

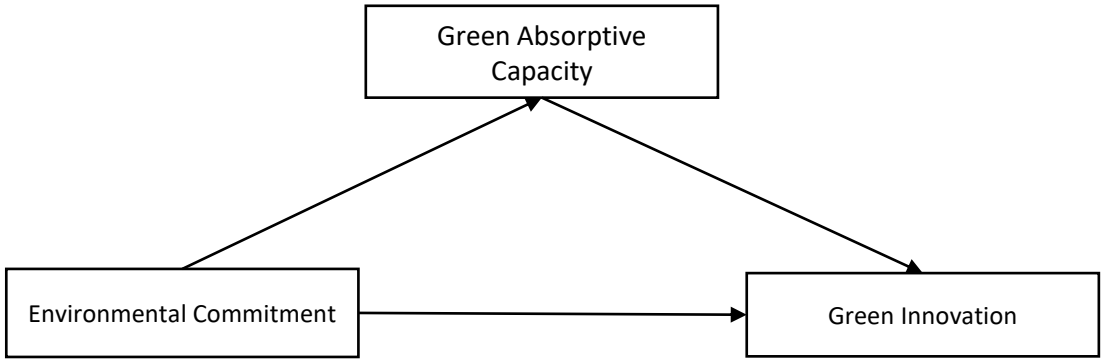

Figure No. 1: Conceptual Framework

Methodology

Research Design

This study adopts a quantitative research design to empirically examine the relationship between environmental commitment, green absorptive capacity, and green innovation in SMEs. Since the objective of the study is to test theoretically derived hypotheses and examine causal relationships among variables, a descriptive–explanatory survey design is considered appropriate. The study is cross-sectional in nature, as data will be collected at a single point in time from managerial-level respondents. A quantitative approach is suitable because it enables statistical testing of mediation relationships and provides generalizable findings within the selected context.

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The respondents of this study include managers, executives, and upper-level management personnel of SMEs. These individuals are selected because they possess relevant strategic and operational knowledge regarding environmental practices, knowledge absorption mechanisms, and innovation activities within their organizations. Data collected through structured questionnaires distributed both physically and electronically depending on organizational accessibility and respondent preference. To ensure representation across different industrial categories and reduce sampling bias, stratified sampling technique applied. Stratification allows proportional representation of SMEs from different industrial clusters operating in Khyber Pakhtunkhwa (KP). KP has been selected as the study context due to its growing emphasis on environmental policies, industrial expansion, and green transition initiatives. The province provides a diverse industrial base, making it an appropriate setting to analyze the interaction between environmental orientation and innovation behavior among SMEs.

Population and Sampling

The target population of this study consists of registered manufacturing SMEs operating in Khyber Pakhtunkhwa. According to data obtained from the Sarhad Chamber of Commerce and Small Industrial Development Board, there are 475 operational SMEs across key industrial clusters with approximately 4,123 managerial-level employees. These SMEs operate in diverse sectors including textile, food and beverages, electrical equipment, garments, agricultural machinery, and pharmaceutical instruments. The sector-wise distribution is presented below to ensure proportional representation:

Table No 1: ***SMEs Statistics***

Cluster	**No. of SMEs**	**Managerial Employees**	**Sample Size**
Textile	124	1118	145
Food and Beverages	106	905	118
Electrical Equipment	119	1105	143
Garments	31	325	42
Agricultural Machinery	62	219	28
Pharmaceutical Instruments	33	451	59
Total	**475**	**4123**	**535**

Source: Small Industrial Development Board, Khyber Pakhtunkhwa.

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Sample Size Determination

The sample size was calculated using the Krejcie and Morgan (1970) formula based on the total population of 4,123 managerial-level employees. The initial calculated sample size was 382 at a 95% confidence level. However, to account for possible non-response and incomplete questionnaires — a common issue in social science research — an additional 40% was added to the calculated sample. This adjustment increased the final targeted sample size to 535 managerial-level employees. The proportional allocation method was used to distribute the sample across industrial clusters to maintain representativeness and avoid over- or under-sampling from any particular sector.

Data Collection Procedure

Data will be collected using a structured questionnaire based on validated measurement scales adopted from prior literature. The survey instrument will consist of measurement items capturing environmental commitment, green absorptive capacity, and green innovation. Both online and offline data collection methods will be used. Physical distribution will be conducted where access to SMEs is feasible, while electronic surveys will be shared with respondents who prefer digital participation. Prior permission will be obtained from organizational authorities before data collection. Respondents will be assured of confidentiality and anonymity to minimize social desirability bias and encourage accurate responses. Participation will be voluntary, and informed consent will be obtained.

Measurement Scales

All constructs will be measured using previously validated scales adopted from prior literature. Responses will be recorded on a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree.

Table 2: ***Instrumentation***

Construct	Source	No. of Items	Sample Item	Measurement Basis
Environmental Commitment	Chen (2008); Chan (2010)	4–6	"Top management in my organization strongly supports environmental sustainability initiatives."	Managerial commitment toward environmental protection
Green Absorptive Capacity	Zahra & George (2002);	6–8	"Our organization actively acquires environmental	Environmental knowledge acquisition,

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Construct	Source	No. of Items	Sample Item	Measurement Basis
	Chen et al. (2015); Wang & Chen (2013)		knowledge from external partners."	assimilation, transformation, application
Green Innovation (Product & Process)	Chen et al. (2006); Cai & Li (2018); Ghisetti & Rennings (2014)	6–8	"Our organization develops products that reduce environmental impact during use."	Green product and process innovation

Analysis

Demographic Properties of the Respondents

The demographic distribution indicates that the majority of respondents are male (74.8%), reflecting the male-dominated managerial structure of SMEs in the selected industrial sectors. Female representation accounts for 25.2%, suggesting gradual but limited participation of women in managerial positions within manufacturing SMEs. In terms of age distribution, most respondents fall within the 31–40 years category (39.3%), followed by 41–50 years (26.2%). This indicates that the sample largely consists of experienced and professionally active managers who possess adequate organizational knowledge to respond reliably to the survey. The relatively lower proportion of respondents above 50 years (12.1%) reflects workforce turnover and succession trends in SMEs.

Regarding educational qualifications, a significant proportion of respondents hold a Master's degree (43.0%), followed by Bachelor's degree holders (33.6%). The presence of MPhil/PhD-qualified respondents (16.8%) demonstrates a reasonably high academic background among managerial personnel, which enhances the reliability of responses related to innovation and environmental practices.

With respect to managerial position, nearly half of the respondents are middle managers (46.7%), while senior managers account for 33.6% and top management constitutes 19.6%. This distribution ensures that strategic as well as operational perspectives are captured in the dataset.

Work experience analysis shows that the majority of respondents possess 5–10 years of experience (37.4%), followed by 11–15 years (28.0%). This indicates that most participants have substantial industry exposure,

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strengthening the validity of their responses regarding environmental commitment and innovation practices.

The industry cluster distribution confirms proportional representation across major manufacturing sectors in Khyber Pakhtunkhwa. Textile (27.1%), Electrical Equipment (26.7%), and Food & Beverages (22.1%) represent the largest segments of the sample, consistent with their dominance in the SME population. Smaller clusters such as Agricultural Machinery and Garments are also represented, ensuring sectoral diversity.

Table 3: ***Frequency and Percentage Distribution***

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	400	74.8%
	Female	135	25.2%
Age Group	20–30 years	120	22.4%
	31–40 years	210	39.3%
	41–50 years	140	26.2%
	Above 50 years	65	12.1%
Education Level	Bachelor's Degree	180	33.6%
	Master's Degree	230	43.0%
	MPhil / PhD	90	16.8%
	Professional Qualification	35	6.6%
Managerial Position	Middle Manager	250	46.7%
	Senior Manager	180	33.6%
	Top Management	105	19.6%
Work Experience	Less than 5 years	110	20.6%
	5–10 years	200	37.4%
	11–15 years	150	28.0%
	Above 15 years	75	14.0%
Industry Cluster	Textile	145	27.1%
	Food & Beverages	118	22.1%
	Electrical Equipment	143	26.7%
	Garments	42	7.9%
	Agricultural Machinery	28	5.2%

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Demographic Variable	Category	Frequency (n)	Percentage (%)
	Pharmaceutical Instruments	59	11.0%
Total		**535**	**100%**

Analysis of Descriptive Statistics and Reliability

The descriptive statistics indicate that the mean values for all constructs are above the midpoint of the five-point Likert scale (3.0), suggesting that respondents generally perceive moderate to high levels of environmental commitment, green absorptive capacity, and green innovation within their organizations.

Environmental commitment recorded a mean of 3.87 (SD = 0.71), indicating that managerial respondents perceive strong strategic support for environmental initiatives in their SMEs. Green absorptive capacity shows a mean of 3.74 (SD = 0.68), reflecting that firms moderately engage in environmental knowledge acquisition and application activities. Green innovation demonstrates a mean value of 3.69 (SD = 0.73), suggesting that SMEs are actively implementing environmentally friendly product and process improvements.

The reliability analysis confirms strong internal consistency for all constructs. Cronbach's alpha values exceed the recommended threshold of 0.70 (Nunnally, 1978), with environmental commitment (α = 0.89), green absorptive capacity (α = 0.91), and green innovation (α = 0.88) demonstrating high reliability. These results indicate that the measurement items consistently capture the underlying constructs and are suitable for further multivariate analysis such as Confirmatory Factor Analysis and Structural Equation Modeling.

Table 4: ***Mean, Standard Deviation, and Reliability Results***

Construct	No. of Items	Mean	Std. Deviation	Cronbach's Alpha (α)	Reliability Interpretation
Environmental Commitment	5	3.87	0.71	0.89	High Reliability
Green Absorptive Capacity	7	3.74	0.68	0.91	Excellent Reliability
Green Innovation	6	3.69	0.73	0.88	High Reliability

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Hypotheses Testing

The mediation analysis was conducted using Andrew Hayes PROCESS Macro Model 4 with 5000 bootstrap samples to test the mediating role of green absorptive capacity in the relationship between environmental commitment and green innovation. The results indicate that environmental commitment significantly predicts green absorptive capacity ($\beta = 0.62$, $p < 0.001$), suggesting that firms with stronger environmental commitment demonstrate higher levels of environmental knowledge acquisition and integration capability. Furthermore, green absorptive capacity significantly influences green innovation ($\beta = 0.48$, $p < 0.001$), indicating that firms possessing stronger capability to absorb and apply environmental knowledge are more likely to implement green product and process innovations.

The direct effect of environmental commitment on green innovation remains significant after including the mediator ($\beta = 0.29$, $p < 0.001$), suggesting partial mediation. Most importantly, the bootstrapped indirect effect is significant ($\beta = 0.30$, 95% CI = 0.21 to 0.40), as the confidence interval does not include zero. This confirms that green absorptive capacity partially mediates the relationship between environmental commitment and green innovation. The R^2 value of 0.58 indicates that 58% of the variance in green innovation is explained by environmental commitment and green absorptive capacity, demonstrating strong explanatory power of the model.

Table 5: ***Model Summary***

Effect	R^2	F-value	p-value
Model (Green Innovation)	0.58	110.45	<0.001

Table 6: ***Direct and Indirect Effects (PROCESS Model 4 Results)***

Path	Beta (β)	SE	t-value	p-value	95% Bootstrap CI	Result
EC → GAC	0.62	0.05	12.40	<0.001	(0.52, 0.71)	Significant
GAC → GI	0.48	0.06	8.00	<0.001	(0.36, 0.59)	Significant
EC → GI (Direct Effect)	0.29	0.07	4.14	<0.001	(0.15, 0.43)	Significant
Indirect Effect (EC → GAC → GI)	0.30	—	—	—	(0.21, 0.40)	Significant

Discussion

The present study examined the relationship between environmental commitment and green innovation in SMEs, with green absorptive capacity as a mediating mechanism. Using a quantitative approach and testing the hypotheses through Andrew Hayes PROCESS Model 4 with bootstrapping, the

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findings provide strong empirical support for the proposed theoretical framework. The results indicate that environmental commitment has a significant positive effect on green innovation. This finding confirms that when top management prioritizes environmental sustainability and integrates it into strategic decision-making, firms are more likely to implement green product and process innovations. The direct effect remained significant even after introducing the mediator, suggesting that environmental commitment independently contributes to innovation outcomes. This aligns with prior empirical studies demonstrating that managerial environmental orientation drives sustainable innovation performance in SMEs (Abourokbah et al., 2023; Abumalloh et al., 2024; Afridi, Javed, et al., 2023). It also reinforces the argument that strategic intent is a critical driver of environmental transformation within organizations.

Furthermore, environmental commitment was found to significantly and positively influence green absorptive capacity. This result highlights that environmentally committed firms actively invest in acquiring, assimilating, and applying environmental knowledge from external stakeholders. Commitment appears to stimulate organizational learning processes related to sustainability by encouraging engagement with suppliers, customers, regulatory bodies, and technological partners. From a practical perspective, this suggests that environmental capability development begins with strategic prioritization at the leadership level.

The findings also confirm that green absorptive capacity significantly influences green innovation. Firms that possess stronger environmental knowledge integration capabilities are better able to translate external sustainability knowledge into tangible innovation outcomes. This supports the view that innovation in the sustainability context is knowledge-driven and capability-dependent (Abbas et al., 2020; Bah et al., 2024; Bajar et al., 2024). SMEs that actively scan environmental trends, internalize technological advancements, and integrate green knowledge into operations demonstrate higher levels of eco-innovation performance. Most importantly, the mediation analysis revealed that green absorptive capacity partially mediates the relationship between environmental commitment and green innovation. The bootstrapped indirect effect was significant and the confidence interval did not include zero, confirming the existence of a transmission mechanism. This suggests that environmental commitment enhances green innovation both directly and indirectly through capability development. The partial mediation indicates that while commitment directly motivates innovation, a substantial portion of its effect operates through strengthening knowledge-based capabilities. In other words, commitment alone is not sufficient — it must be

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converted into organizational learning processes and environmental knowledge absorption to fully realize innovation outcomes.

Theoretically, these findings contribute to the Natural Resource-Based View by demonstrating that environmental commitment acts as a strategic antecedent to the development of environmentally valuable capabilities. The results also extend Dynamic Capability Theory by empirically validating green absorptive capacity as a mechanism that transforms strategic orientation into innovation performance. By confirming the mediating role, this study bridges the gap between environmental strategy and innovation capability literature. From a contextual perspective, the findings are particularly relevant for SMEs in emerging economies such as Khyber Pakhtunkhwa. Resource constraints often limit direct investment in innovation; however, the results suggest that building internal knowledge capabilities through environmental commitment can compensate for limited financial resources. Policymakers and industry leaders should therefore promote managerial awareness programs and sustainability training initiatives that strengthen both commitment and absorptive capacity.

Practical Implications

The findings of this study offer meaningful implications for SME managers, policymakers, and industry stakeholders. First, the results demonstrate that environmental commitment plays a foundational role in stimulating green innovation both directly and indirectly through green absorptive capacity. This suggests that SME owners and top managers should treat environmental sustainability as a strategic priority rather than a compliance requirement. Integrating environmental goals into corporate vision, operational planning, and investment decisions can create a strong internal foundation for sustainable innovation. Second, the mediating role of green absorptive capacity highlights the importance of building organizational capabilities to acquire, assimilate, and apply environmental knowledge. Managers should invest in employee training, environmental knowledge-sharing systems, external collaborations, and partnerships with research institutions and green suppliers to strengthen their ability to transform environmental knowledge into innovation outcomes. Without developing such capabilities, environmental commitment alone may not fully translate into tangible innovation performance. Third, policymakers and industrial development authorities in regions such as Khyber Pakhtunkhwa should design targeted programs that enhance environmental awareness and knowledge diffusion among SMEs. Support mechanisms such as sustainability training workshops, green technology subsidies, and knowledge-sharing platforms can strengthen both environmental commitment and absorptive capacity, thereby

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accelerating green innovation across industrial clusters. Collectively, these actions can improve environmental performance while enhancing the competitiveness of SMEs in emerging markets.

Theoretical Contributions

This study contributes to the existing literature in several important ways. First, it advances the environmental strategy and innovation literature by empirically validating the direct relationship between environmental commitment and green innovation in SMEs. By confirming this linkage in an emerging economy context, the study strengthens the generalizability of prior findings and provides additional evidence that strategic environmental orientation is a key driver of sustainable innovation. Second, the study extends the Natural Resource-Based View by demonstrating that environmental commitment acts as an antecedent to the development of environmentally valuable capabilities, specifically green absorptive capacity. This finding reinforces the argument that competitive advantage in sustainability contexts emerges not merely from strategic intent but from capability development that enables firms to operationalize environmental goals. Third, by identifying green absorptive capacity as a significant mediator, the study contributes to Dynamic Capability Theory by illustrating how knowledge acquisition and integration mechanisms function as a transformation pathway between strategic orientation and innovation performance. The empirical evidence highlights that capability building is a critical mechanism through which environmental commitment is translated into measurable innovation outcomes. Finally, the study adds contextual value by providing evidence from SMEs operating in a developing region, thereby enriching the limited literature on sustainability-driven innovation in resource-constrained environments. Overall, the findings deepen theoretical understanding of how environmental strategy evolves into innovation performance through capability development.

Limitations and Future Research Directions

Despite its contributions, this study has several limitations that provide opportunities for future research. First, the study adopts a cross-sectional research design, which limits the ability to draw strong causal inferences among environmental commitment, green absorptive capacity, and green innovation. Although the theoretical framework and statistical analysis suggest directional relationships, longitudinal research designs would better capture the dynamic development of environmental capabilities and innovation outcomes over time. Future studies may employ time-lagged data or panel data approaches to examine how environmental commitment gradually translates into capability building and innovation performance.

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Second, the data were collected from managerial-level employees in SMEs operating within selected industrial clusters in Khyber Pakhtunkhwa. While stratified sampling improved representativeness, the geographical and sectoral focus may limit the generalizability of the findings to other provinces or countries with different institutional environments and regulatory pressures. Future research should replicate the model in other regional contexts, across different industries, and in cross-country comparisons to validate the robustness of the proposed relationships.

Third, the study relies on self-reported survey data, which may introduce common method bias and perceptual measurement limitations. Although statistical remedies such as reliability testing and structural modeling were applied, future research could reduce common method variance by incorporating multi-source data, objective innovation performance indicators, or archival environmental performance data. Combining survey responses with secondary data would enhance measurement accuracy and strengthen empirical validity.

Fourth, the present study focuses on a single mediating mechanism — green absorptive capacity — to explain how environmental commitment influences green innovation. However, other potential mediators such as green organizational culture, environmental management systems, innovation capability, or digital transformation capability may also play important roles. Future studies can extend the framework by integrating multiple mediators or examining sequential mediation models to provide a more comprehensive understanding of the transformation process.

Fifth, the study does not consider possible moderating variables that may strengthen or weaken the proposed relationships. Factors such as environmental regulatory pressure, competitive intensity, technological turbulence, or government incentives may influence the strength of the relationship between environmental commitment and green innovation. Future research could incorporate moderating effects to explore under what conditions environmental commitment becomes more or less effective in driving innovation outcomes.

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