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Dynamic Capabilities and Environmental Performance of High-Tech SMEs in Pakistan – The Role of Eco-Innovation and Female Executives

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Background/Purpose: This study examines the relationship between dynamic capabilities (DCs) and environmental performance (EP) in high-tech SMEs in Pakistan, focusing on the key dimensions of sensing, seizing, and reconfiguration. Additionally, it explores the mediating role of environmental innovation (EI) and the moderating effect of female leadership on this relationship.

Methods: A quantitative research approach was employed, using a structured questionnaire distributed among male and female Chief Executive Officers (CEOs), senior management personnel, and executives in high-tech SMEs. Data were analysed using structural equation modelling (SEM) to assess the relationships between DCs, environmental innovation, and environmental performance.

Results: The findings indicate that seizing capabilities significantly enhances environmental performance, with a one-point increase leading to a 0.282-point improvement. Similarly, reconfiguration contributes positively, with a one-point increase resulting in a 0.227-point improvement. Both process innovation (path coefficient = 0.384, p = 0.001) and product innovation (path coefficient = 0.157, p = 0.043) positively influence environmental performance. However, female leadership did not exhibit a significant direct effect on environmental performance. Notably, female moderators negatively impacted the relationship between process innovation and environmental performance (-0.328), suggesting that in lower hierarchical positions, female inclusion may reduce the effectiveness of process innovation in achieving sustainability goals.

Conclusions: The study provides empirical evidence on the role of dynamic capabilities and environmental innovation in enhancing sustainability in high-tech SMEs. It highlights the need for firms to strengthen their seizing and reconfiguration capabilities to improve environmental performance. Additionally, eco-innovation should be encouraged, and gender diversity in leadership should be strategically considered when designing innovation and sustainability strategies. These findings offer valuable insights for policymakers and industry practitioners aiming to foster sustainable business practices in high-tech SMEs in Pakistan.

Keywords: *Dynamic capabilities, Environmental performance, High-Tech SMEs, Eco-Innovation, Female leadership*

1 Introduction

The increasing urgency of environmental sustainability has prompted organisations across industries to integrate eco-innovation and sustainability-driven strategies into their operations. Sustainable business practices are crucial to long-term success as companies strive to align their strategic goals with environmental and social respon-

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sibilities (Esty & Winston, 2009; Lubin & Esty, 2010). The dynamic business environment demands that organisations develop capabilities to sense and respond to external pressures, including regulatory changes, consumer preferences, and technological advancements (Teece, 2007). In this regard, dynamic capabilities (DCs) serve as a critical theoretical framework, explaining how organisations can adapt, innovate, and remain competitive while pursuing environmental sustainability (Eisenhardt & Martin, 2000; Zollo & Winter, 2002).

Despite growing scholarly interest in dynamic capabilities and their role in fostering environmental performance (Reyes-Santiago et al., 2019; Dangelico & Pontrandolfo, 2015), empirical research remains limited in certain geographical contexts. Specifically, there is a lack of research investigating the impact of the three primary dimensions of dynamic capabilities—sensing, seizing, and reconfiguration—on environmental performance in emerging economies such as Pakistan (Eikelenboom & de Jong, 2019). This study aims to bridge this gap by examining how high-tech small and medium-sized enterprises (SMEs) in Pakistan leverage dynamic capabilities to enhance their environmental performance.

Additionally, eco-innovation has been identified as a potential mediator between dynamic capabilities and environmental performance, as organisations that embrace innovation-driven environmental strategies tend to achieve superior sustainability outcomes (Costantini et al., 2017; Arranz et al., 2020). However, the moderating role of female leadership in this relationship remains underexplored. Research suggests that gender diversity in leadership can influence corporate social responsibility and environmental sustainability efforts (Glass et al., 2016; Liu et al., 2022). This study investigates whether female executives strengthen or weaken the connection between dynamic capabilities, eco-innovation, and environmental performance.

This study contributes to the growing body of literature on dynamic capabilities and environmental performance by providing empirical evidence from the high-tech sector in Pakistan. The research employs a quantitative methodology using structured questionnaires, allowing for statistical analysis of the relationships among dynamic capabilities, eco-innovation, and environmental performance. The findings offer valuable implications for businesses and policymakers, emphasising the need for strategic investments in eco-innovation and dynamic capabilities while considering the influence of gender diversity in leadership.

Next, we present the theoretical background that underpins our study. We explore a variety of topics that are essential for understanding the framework and context of our research.

Dynamic Capabilities and Environmental Performance

The dynamic capabilities framework, introduced by Teece et al. (1997), posits that organisations achieve and sustain competitive advantage by continuously adapting and reconfiguring their resources in response to changing environmental conditions. Dynamic capabilities consist of three core elements: sensing opportunities, seizing them, and reconfiguring organisational resources to maintain competitiveness (Teece, 2007). Scholars argue that these capabilities enable organisations to pursue environmental sustainability, facilitating eco-innovation integration into business strategies (Helfat & Peteraf, 2003; Buzzao & Rizzi, 2021).

Empirical studies suggest that organisations with well-developed dynamic capabilities are more likely to engage in proactive environmental strategies, thereby improving their environmental performance (Eikelenboom & de Jong, 2019). Specifically, sensing allows organisations to identify market trends and regulatory changes related to sustainability, seizing enables them to capitalise on eco-friendly innovations, and reconfiguration ensures continuous adaptation to new environmental challenges (Reyes-Santiago et al., 2019). This study explores how these three dimensions of dynamic capabilities impact environmental performance within high-tech SMEs in Pakistan.

Eco-Innovation as a Mediator

Eco-innovation refers to developing and implementing new products, services, or business practices that reduce environmental impact while maintaining economic viability (Dangelico et al., 2017; Qi et al., 2013). Scholars emphasise that eco-innovation is a crucial mechanism through which dynamic capabilities contribute to environmental performance (Costantini et al., 2017). Firms that integrate eco-innovation into their business models can achieve greater resource efficiency, regulatory compliance, and competitive differentiation (Arranz et al., 2020).

Recent research highlights the mediating role of eco-innovation in linking dynamic capabilities to environmental outcomes. For instance, organisations that effectively sense environmental challenges are more likely to invest in eco-innovation, enhancing their environmental performance (Cai & Li, 2018). Similarly, organisations with strong reconfiguration capabilities can align technological advancements with sustainability goals, providing more substantial environmental benefits (Dangelico et al., 2017). This study examines whether eco-innovation mediates the relationship between dynamic capabilities and environmental performance in high-tech SMEs.

The Moderating Role of Female Leadership

The role of female leadership in corporate sustainability has gained significant attention in recent years (Post et al., 2011; Liu et al., 2022). Research suggests that female executives prioritise ethical considerations, corporate social responsibility, and environmental initiatives more than their male counterparts (Glass et al., 2016). However, the extent to which female leadership moderates the impact of dynamic capabilities on environmental performance remains largely unexplored.

Studies indicate that gender-diverse leadership teams are more likely to adopt sustainability-oriented strategies, foster innovation, and drive long-term environmental goals (Boulouta, 2013; García-Granero et al., 2018). However, some scholars argue that structural and cultural barriers may limit the effectiveness of female executives in shaping environmental performance outcomes (Eagly & Johannesen-Schmidt, 2001). This study investigates whether female executives moderate the relationship between dynamic capabilities and environmental performance, particularly through the lens of eco-innovation.

Dynamic Capabilities, Eco-Innovation, and Environmental Performance: Hypotheses Development

This section delves into the development of hypotheses, drawing upon existing literature and theoretical frameworks to examine the relationships between dynamic capabilities, eco-innovation, environmental performance, and the moderating role of female executives.

Dynamic Capabilities and Environmental Performance

Dynamic capabilities are crucial for navigating the complexities of sustainability in a rapidly changing environment (Arend, 2014; O'Neil & Usbasaran, 2016). They provide firms the adaptive flexibility needed for continuous modifications and improvements (Arend, 2014; Chen & Chang, 2013). Research has shown a positive link between dynamic capabilities and firm performance, including profitability (Drnevich & Kriauciunas, 2011; Protogerou et al., 2011). However, the relationship between dynamic capabilities and environmental performance is less clear-cut. Some studies indicate a positive association (Mousavi et al., 2018), while others suggest a negative or ambivalent impact (Protogerou et al., 2011; Akhtar et al., 2020).

Drawing on the Resource-Based View (RBV), which emphasises the importance of valuable, rare, inimitable, and non-substitutable (VRIN) resources for achieving competitive advantage (Peteraf & Barney, 2003), this study posits that dynamic capabilities, as a specific type of capability, can enhance a firm's environmental performance. Therefore, the first hypothesis is:

H1: Dynamic capabilities positively impact a firm's environmental performance in high-tech SMEs in Pakistan.

Dynamic Capabilities and Eco-Innovation

Eco-innovation, encompassing environmentally sustainable products and practices (Teece, 2007), has been positively linked to dynamic capabilities in several studies (Dangelico et al., 2017; Moroni et al., 2022; Zhou et al., 2018). Dynamic capabilities enable firms to sense, seize, and reconfigure resources to address environmental concerns and foster eco-innovation (Teece, 2007; Tseng & Lee, 2014). The RBV, extended to include the natural environment (Cheng et al., 2014), suggests that eco-innovation can be viewed as a distinctive green capability developed through various resources. Eco-innovation is increasingly recognised as a crucial driver of economic growth and sustainable development (Baird et al., 2014; Aydıner et al., 2018).

Building on these findings, this study proposes:

H2: Dynamic capabilities positively impact eco-innovation in high-tech SMEs in Pakistan.

Eco-Innovation and Environmental Performance

Eco-innovation, aimed at mitigating environmental damage (Costantini, 2017), has been shown to positively influence environmental performance (Küçükoğlu & Pinar, 2015; Cai & Li, 2018; Fernando & Wah, 2017). It can lead to a "double externality" by reducing environmental impacts and generating knowledge spillovers (Cai & Li, 2018). Eco-innovation is a key strategy for addressing environmental challenges and gaining a competitive advantage (Yurdakul & Kazan, 2020).

This study hypothesises that eco-innovation mediates the relationship between dynamic capabilities and environmental performance:

H3: Eco-innovation mediates the relationship between dynamic capabilities and the environmental performance of high-tech companies in Pakistan.

Female Executives as Moderators

Research suggests a potential link between female executives and environmental performance (Tran & Pham, 2020; Post et al., 2011). Upper Echelon Theory posits that executives' backgrounds, including gender, influence their strategic decisions (Hambrick & Mason, 1984; Hambrick, 2007). Studies have shown that female leaders are more concerned with ethics, social responsibility, and environmental sustainability (Eagly & Johannesen-Schmidt, 2001; Boulouta, 2013).

This study proposes that female executives play a moderating role in the relationship between dynamic capabilities and environmental performance, both directly and indirectly, through eco-innovation:

H4: The presence of female executives plays a moderating role in the relationship between dynamic capabilities, eco-innovation, and environmental performance of firms in high-tech SMEs in Pakistan.

These hypotheses will be tested using quantitative data collected from high-tech SMEs in Pakistan. The findings will contribute to a better understanding of how dynamic capabilities, eco-innovation, and female leadership can enhance environmental performance and drive sustainable competitive advantage.

This study integrates DC, RBV, and eco-innovation frameworks to examine their impact on environmental performance, contributing to sustainability discourse in high-tech SMEs.

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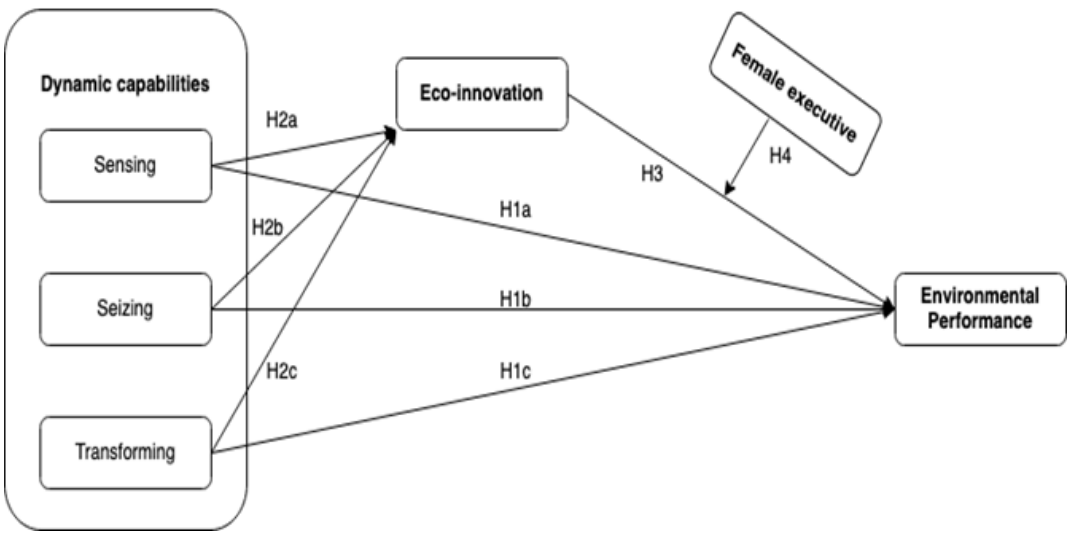

Figure 1: Theoretical framework

Table 1: Table illustrating the hypothesis number and its relevant testing theory

Hypothesis	Testing Theory
H1	Resource-based View
H2	Resource-based View
H3	Resource-based View
H4	Upper Echelon

Research Methodology

This study employs a quantitative research approach to investigate the relationship between dynamic capabilities, eco-innovation, and environmental performance in high-tech SMEs in Pakistan. This approach is chosen because it can test hypotheses, establish cause-and-effect relationships, and make predictions based on numerical data (Johnson & Christensen, 2014). The quantitative approach allows for the collection of precise, structured, and validated data, enabling the analysis of statistical relationships and the generalisation of findings to a broader population (Almeida et al., 2017).

The research is guided by a positivist philosophy, which emphasises objectivity, measurement, and the testing of hypotheses through quantitative data analysis (Creswell & Creswell, 2005). This aligns with the study's focus on collecting numerical data through questionnaires and analysing it using statistical techniques to draw objective conclusions.

Sampling Technique

A stratified sampling technique ensures that the sample adequately represents the population of interest. This technique involves dividing the population into smaller groups based on specific characteristics and randomly selecting participants from each group (Sharma, 2017). In this study, the population consists of high-tech SMEs in Pakistan. The sample is stratified based on firm size and industry sub-sector to ensure representation across different types of high-tech firms. The final sample size for this study is 117 firms. The respondents who completed the questionnaires were primarily mid- to senior-level managers involved in strategic decision-making, innovation, or sustainability roles. Among the 117 companies, the total number of individual respondents was 234, as multiple executives from the same firm participated in some cases. Of the respondents, 63% were male and 37% were female. Specifically, 18 women were identified as holding positions at the highest level of company executives, including CEO, Director, or Head of Department. Meanwhile, 39 women were in lower-level executive or managerial positions, including operations, finance, or innovation management.

Measurements

The study utilises established scales and measures from the existing literature to assess the key constructs:

- **Dynamic Capabilities:** Measured using a 5-point Likert scale, capturing the three dimensions of sensing, seizing, and reconfiguration (Zhou et al., 2019). Items assess the frequency of environmental scanning, observation of changes in values and lifestyles, participation in professional activities, adoption of best practices, development of new business methods, reaction to environmental changes, renewal of business processes, identification of new ways to achieve objectives, implementation of new management methods, and the use of existing resources in new ways (Nieves & Haller, 2014; Jantunen et al., 2018; Wilden et al., 2013).
- **Eco-Innovation:** Measured using a 5-point Likert scale, capturing both product and process eco-innovation (Barriga et al., 2022; García-Granero et al., 2018). Items assess the development of new eco-products through technologies for recycling and decomposition, innovative updates to manufacturing processes to meet environmental standards, reduction of chemical waste, waste minimisation, and recycling of waste, water, and materials.
- **Environmental Performance:** Measured using a 5-point Likert scale, capturing various aspects of environmental performance (Barriga et al., 2022). Items assess the decrease in consumption of hazardous materials, reduction in environmental accidents, improvement of the environmental situation, reduction in air emissions, and reduction of solid waste.

Research Analysis Tool

Structural Equation Modeling (SEM) is employed to analyse the collected data. SEM is a powerful statistical technique that allows for examining multiple variables simultaneously, considering their interdependencies (McDonald & Ho, 2002). It enables the assessment of measurement properties, the construction of latent variables, and the testing of theoretical models (Byrne, 2016; Becker et al., 2012; Hair et al., 2014). SEM is particularly well-suited for this study as it allows for examining mediating and moderating effects, helping to identify the mechanisms through which dynamic capabilities influence environmental performance and the role of eco-innovation and female executives in this relationship.

SEM is chosen for this study because it provides a comprehensive framework for analysing complex relationships between multiple variables, ensuring the rigour and validity of the analysis. SEM will enable a thorough examination of the hypotheses and contribute to a deeper understanding of the complex interplay between dynamic capabilities, eco-innovation, female leadership, and environmental performance in the high-tech industry.

Data Analysis

This chapter presents the data analysis collected through the quantitative research methodology described in the previous chapter. The analysis examines dynamic capabilities' direct and indirect effects on environmental performance, with eco-innovation as a mediator and female executives as a moderator. The analysis uses Structural Equation Modeling (SEM) with the Smart-PLS software.

Structural Equation Modeling (SEM)

SEM is a powerful statistical technique widely used in social and behavioural sciences to analyse complex relationships between multiple variables (Gana & Broc, 2019). It allows for examining direct and indirect effects and mediating and moderating variables, making it well-suited for this study (Hox & Bechger, 1999; Rahman et al., 2015).

This study employs Partial Least Squares-SEM (PLS-SEM), a variance-based SEM approach suitable for estimating complex cause-effect relationship models with latent variables (Hair et al., 2014; Sarstedt et al., 2021). PLS-SEM consists of two sub-models: the measurement model, which defines the relationships between observed variables and latent constructs, and the structural model, which specifies the relationships between the latent constructs (Hossan et al., 2020).

Mediating Role of Eco-Innovation

The analysis examines the mediating effect of eco-innovation on the relationship between dynamic capabilities and environmental performance. Full mediation occurs when the direct effect of dynamic capabilities on environmental performance is not significant, but the indirect effect through eco-innovation is significant. Partial mediation occurs when both the direct and indirect effects are significant (Ballen & Salehi, 2021).

The PLS-SEM analysis reveals the following:

- **Direct Effects:** Sensing does not significantly impact environmental performance (β=0.116, P=0.346). However, seizing (β=0.282, P=0.015) and reconfiguration (β=0.227, P=0.045) significantly positively affect environmental performance.
- **Indirect Effects:** The analysis will further examine the indirect effects of dynamic capabilities on environmental performance through eco-innovation, considering both product and process dimensions of eco-innovation.

These findings suggest that while sensing alone may not directly contribute to environmental performance, the ability to seize opportunities and reconfigure resources plays a crucial role in enhancing environmental outcomes. The subsequent analysis will delve deeper into the mediating role of eco-innovation and the moderating influence of female executives to provide a more comprehensive understanding of these relationships.

The previous model (Figure 5.1) examines the direct impact of Dynamic capabilities on Environmental Performance, and we called this the naïve model. Nevertheless, adding Eco-innovation as a mediating variable, which Product Innovation and Process Innovation represent, has changed the impact of dynamic capabilities on Environmental Performance. Results in Table 5.2 show the impact of dynamic capabilities on Environmental Performance after adding the mediating variable.

Table 2: The impact of dynamic capabilities on environmental performance. (Niamat, R using PLS-SEM)

Impact	Coefficient	P values
Reconfiguration -> Environmental Performance	0.227	0.045
Seizing -> Environmental Performance	0.282	0.015
Sensing -> Environmental Performance	0.116	0.346

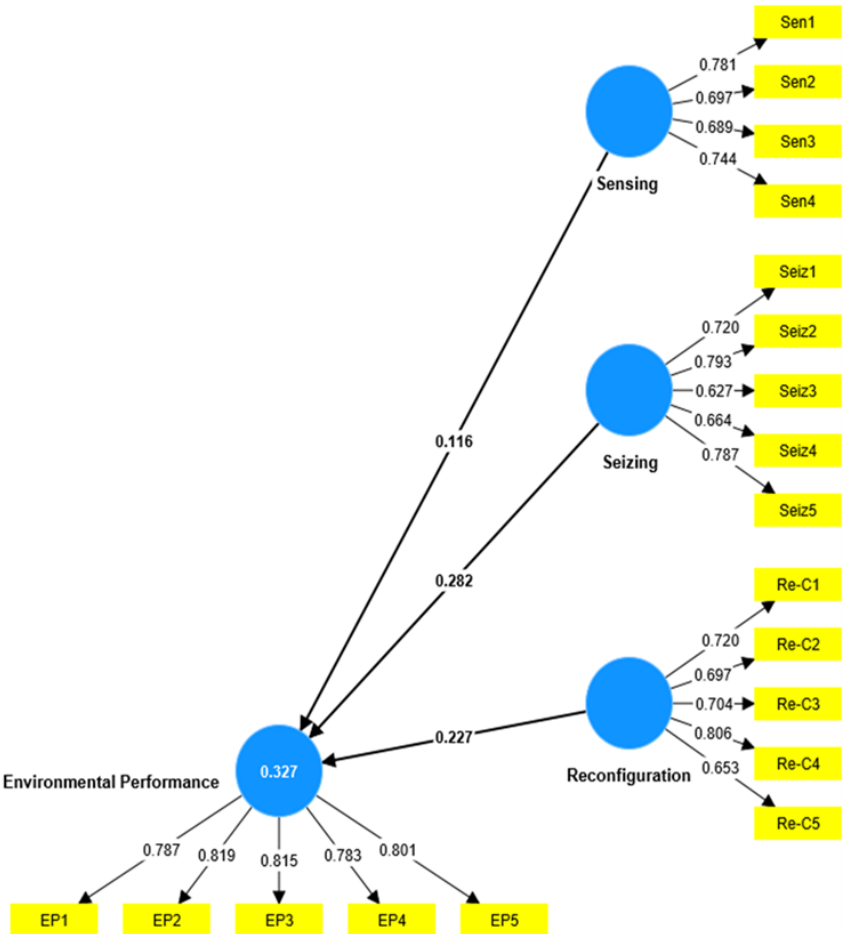

Figure 2: The mediating role of Eco-innovation. (Niamat, R using PLS-SEM)

Table 3: The impact of dynamic capabilities on Environmental Performance through Eco-innovation. (Niamat, R using PLS-SEM)

Impact	Path coefficients	P-value
Process -> Environmental Performance	0.384	0.001
Product -> Environmental Performance	0.157	0.043
Reconfiguration -> Environmental Performance	0.127	0.084
Reconfiguration -> Process	0.191	0.078
Reconfiguration -> Product	0.024	0.862
Seizing -> Environmental Performance	0.091	0.019
Seizing -> Process	0.364	0.003
Seizing -> Product	0.342	0.030
Sensing -> Environmental Performance	0.042	0.313
Sensing -> Process	0.217	0.047
Sensing -> Product	0.006	0.972

Process and Environmental Performance:

The relationship between Process and Environmental Performance becomes significant with a path coefficient of 0.384 and a p-value of 0.001. This indicates that Process innovation now has a significant positive impact on Environmental Performance.

Product and Environmental Performance:

The relationship between Product innovation and Environmental Performance is also significant, with a path coefficient of 0.157 and a p-value of 0.043. This suggests that Product innovation has a positive effect on Environmental Performance.

Reconfiguration and Environmental Performance:

While the path coefficient for Reconfiguration to Environmental Performance remains positive (0.127), it is no longer statistically significant at the conventional significance level (p=0.084).

Seizing and Environmental Performance:

The relationship between Seizing and Environmental Performance is weaker and marginally significant (β=0.091, P=0.019).

Sensing and Environmental Performance:

The relationship between Sensing and Environmental Performance remains non-significant (β=0.042, P=0.313).

Table 04 shows the impact of dynamic capabilities on environmental performance, mediated by eco-innovation, after including control variables. The statistical analysis results indicated that the p-value for the relation between Sensing and Environmental Performance was 0.146. Similarly, the p-value for the relationship between Seizing and Environmental Performance was 0.003. Lastly, the p-value for the relationship between Reconfiguration and Environmental Performance was determined to be 0.168. Based on the data, the dimensions of sensing and reconfiguration do not have a statistically significant effect on environmental performance. However, seizing only has a significant and indirect impact on environmental performance.

Table 4: The impact of dynamic capabilities on environmental performance, mediated by eco-innovation with control variables. (Niamat, R using PLS-SEM)

Impact	Total effects	P values
Process -> Environmental Performance	0.417	0.000
Product -> Environmental Performance	0.124	0.112
Reconfiguration -> Environmental Performance	0.217	0.057
Reconfiguration -> Process	0.191	0.077
Reconfiguration -> Product	0.026	0.850
Seizing -> Environmental Performance	0.288	0.015
Seizing -> Process	0.365	0.003
Seizing -> Product	0.340	0.031
Sensing -> Environmental Performance	0.148	0.239
Sensing -> Process	0.215	0.049
Sensing -> Product	0.007	0.967

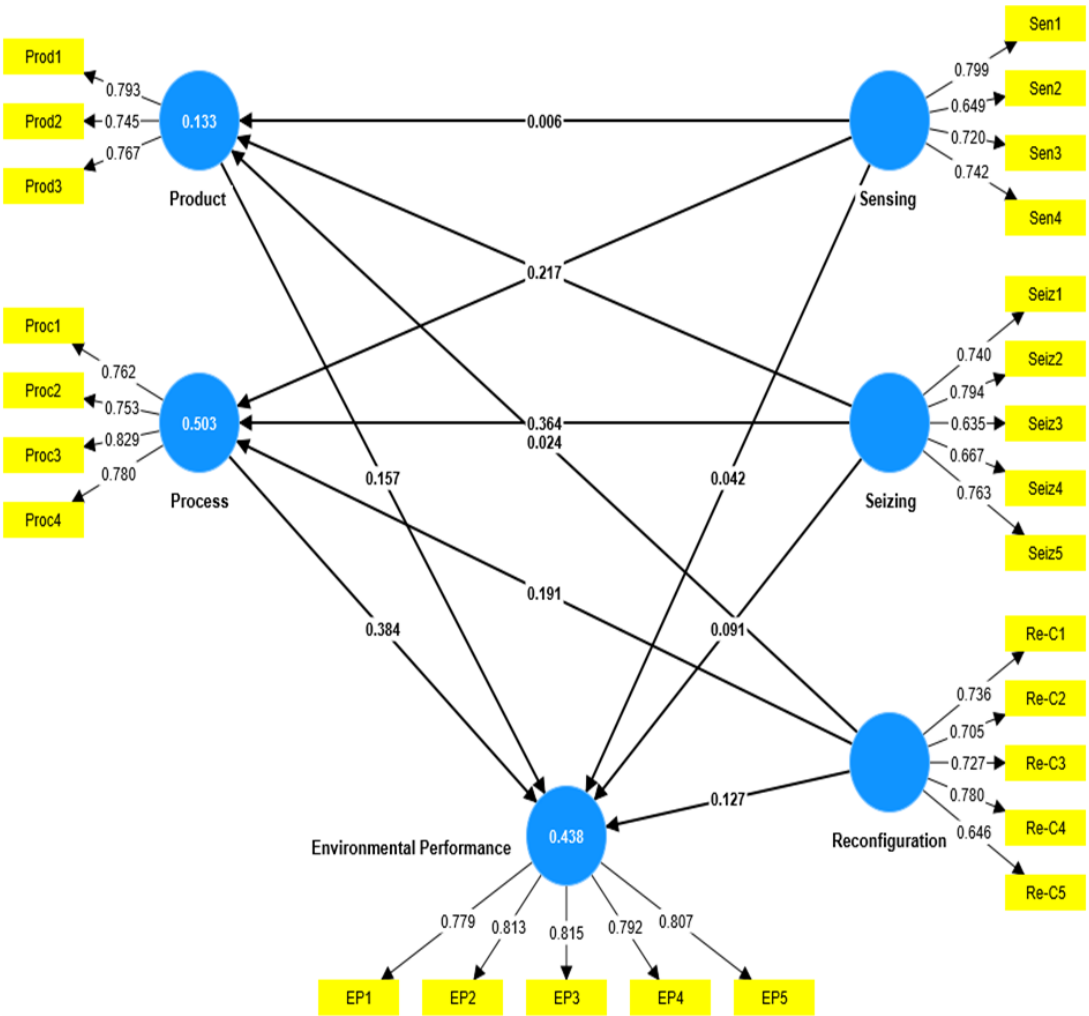

Figure 3: The impact of dynamic capabilities on Environmental Performance through Eco-innovation. (Niamat, R using PLS-SEM)

SEM analysis; the moderating of the female executives on dynamic capabilities and environmental performance.

A moderating effect is caused by a variable (Female) whose variation influences the relationship between an independent and dependent variable. We have an independent variable (dynamic capabilities), a dependent variable (environmental performance), and a moderator (female executives). This section examines the moderating role of female presence on different relationships that affect environmental performance; the following equations examine these relationships.

The following equation represents the naïve model, where Environmental performance is affected by the explanatory variable, the dynamic capabilities, and the Female variable, which represents the existence of females in the High-Tech sector.

$$EP_i = \alpha + \beta_1 DC_i + \gamma\, Female_i + \varepsilon_i \quad (1)$$

Table 05 model (1) shows the results of the naïve model, which examines the factors influencing environmental performance (EP) in the High-Tech sector. The results suggest that dynamic capabilities (DC) have a substantial and statistically significant impact on EP. Specifically, a one-unit increase in dynamic capabilities is associated with a significant 0.750 increase in environmental performance. This suggests that companies with strong dynamic capabilities are more adept at adapting and responding to environmental concerns, leading to better environmental performance outcomes.

However, the presence of females within this High-Tec sector, represented by the variable Female, does not appear to have a statistically significant impact on environmental performance in this model.

Equation (2) represents the impact of DC on EP, and it differs from equation (1) in that it includes other control variables that represent Eco-innovation, namely, Product innovation and Process innovation.

$$EP_i = \alpha + \beta_1 DC_i + \gamma\, Female_i + \beta_2 Product + \beta_3 Process + \varepsilon_i \quad (2)$$

Results in Table 5.4 model (2) demonstrated that DC have a statistically significant impact on EP; a one-unit increase in dynamic capabilities is associated with a significant 0.368 increase in environmental performance. Moreover, the presence of females within these High-tech sectors does not impact environmental performance in this model. However, both Product innovation and Process innovation have a positive and significant impact on environmental performance. A one-unit increase in Product innovation is associated with a significant 0.194-unit increase in environmental performance. A one-unit increase in Process innovation is linked with a significant 0.417-unit increase in environmental performance.

Equation (3) examines the moderating role of female presence in the high-tech industry on the relationship between DC and EP.

$$EP_i = \alpha + \beta_1 DC_i + \gamma\, Female_i + \mu\, DC_i X\, Female_i + \beta_2 Product + \beta_3 Process + \varepsilon_i \quad (3)$$

Results in Table 5.4 model (3) show the extended model that examines the moderating role of female presence in the High-Tech industry on the relationship between dynamic capabilities (DC) and environmental performance (EP).

The continued significance of DC on EP with a coefficient of 0.391 suggests that dynamic capabilities remain a significant driver of environmental performance in the High-Tech industry. The insignificance of the variable representing female presence on EP suggests that, within the context of this model and industry, the gender composition of the workforce does not seem to impact environmental performance independently.

The insignificance of the interaction term between DC and Female implies that this analysis does not observe the moderating effect of female presence on the relationship between dynamic capabilities and environmental performance. It suggests that, in this specific context, the presence of females in the High-Tech industry does not significantly alter how dynamic capabilities influence environmental performance.

Equation (4) examines the moderating role of female presence in the high-tech industry in the relationship between product innovation, which reflects the eco-innovation variable, and EP.

$$EP_i = \alpha + \beta_1 DC_i + \gamma\, Female_i + \beta_2 Product + \mu\, Product\ X\ Female_i + \beta_3 Process + \varepsilon_i \quad (4)$$

Table # model (4) assesses the moderating role of female presence in the High-Tech industry on the relationship between product innovation (reflecting the Eco-innovation variable) and environmental performance (EP); we find that the interaction term between product innovation and female presence is statistically insignificant.

Equation (5) investigates the moderating role of female presence in the high-tech industry in the relationship between process innovation, which again reflects the eco-innovation variable and EP.

$$EP_i = \alpha + \beta_1 DC_i + \gamma\, Female_i + \beta_2 Product + \beta_3 Process + \mu\, Process\ X\ Female_i + \varepsilon_i \quad (5)$$

Table 05 Model (5) demonstrates the same obtained results from equation (4).

Nevertheless, equation (6) examines the moderating role of female presence in High-Tec industry on the relationship between Process innovation and EP; however, we split the sample into those who occupy high positions (top) and those who occupy lower positions (low)

$$\begin{cases} EP_{i,top} \\ EP_{i,low} \end{cases} = \alpha + \beta_1 DC_i + \gamma\, Female_i + \beta_2 Product + \beta_3 Process + \mu\, Process\ X\ Female_i + \varepsilon_i \quad (6)$$

Table 5: The moderating role of female existence on the relationship between Dynamic capabilities, Eco-innovation, and EP (Niamat, R using PLS-SEM)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Naïve	Control	inter1	inter2	inter3	sub1	sub2
DC	0.750***	0.368***	0.391***	0.368***	0.396***	0.244	0.700***
	(0.0896)	(0.104)	(0.119)	(0.105)	(0.104)	(0.207)	(0.132)
Female	0.0668	0.0812	0.258	0.115	0.958**	0.797	1.298***
	(0.178)	(0.169)	(0.567)	(0.500)	(0.458)	(0.839)	(0.383)
		0.197**	0.194**	0.201*	0.174*	0.209*	0.102
		(0.0906)	(0.0907)	(0.103)	(0.0920)	(0.114)	(0.104)
		0.417***	0.417***	0.416***	0.514***	0.578***	0.366***
		(0.108)	(0.108)	(0.111)	(0.115)	(0.179)	(0.135)
Female X DC			-0.0531				
			(0.188)				
Female X				-0.0115			
				(0.174)			
Female X					-0.314*	-0.311	-0.328**
					(0.178)	(0.320)	(0.158)
Constant	0.121	-0.362	-0.436	-0.373	-0.681**	-0.566	-0.885***
	(0.310)	(0.316)	(0.347)	(0.324)	(0.313)	(0.810)	(0.320)
Observations	117	117	117	117	117	68	49
R-squared	0.292	0.426	0.426	0.426	0.441	0.320	0.6898

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

VARIABLES:

(1) Naïve model
(2) Control = With control dimensions of EI product and EI Process
(3) Inter1 = Interaction with EI
(4) Inter2 = Interaction with EI Product
(5) inter3 = Interaction with EI Process
(6) sub1 = Subgroup Top Level Hierarchy
(7) sub2 = Subgroup Lower Level Hierarchy

Table 05 Model (6) and Model (7) examine the moderating role of female presence in the High-Tech industry on the relationship between process innovation and environmental performance (EP); we have uncovered interesting results, especially when considering the distinction between those in high positions (top) and those in lower positions (low).

First, for both samples, process innovation is found to have a significant and positive impact on environmental performance, with a coefficient of 0.578 and 0.366, respectively. This suggests that companies in the High-Tech industry that implement process innovation strategies experience improved environmental performance outcomes, which aligns with the expectation that more efficient processes can reduce waste and resource consumption.

However, when examining the moderating role of female presence in this relationship, a noteworthy pattern emerges for those who occupy lower positions within the organization. For this group, female existence as a moderator negatively affects the relationship between process innovation and environmental performance, with an impact of -0.328. In practical terms, this suggests that in lower-level roles, where individuals may have less influence over decision-making and strategic planning, the presence of females diminishes the positive effects of process innovation on environmental performance.

These findings underscore the complexity of the relationship between gender diversity, innovation, and environmental performance within the High-Tech industry. They suggest that the impact of these factors can vary significantly based on an employee's position within the organization and that the presence of females may have unique effects in different hierarchical contexts.

Discussion

This chapter analyses the findings from the previous chapters to evaluate the hypotheses proposed in the theoretical model. The study focused on understanding how dynamic capabilities affect the environmental performance of Pakistan's small and medium-sized technology companies (SMEs).

Direct Impact of Dynamic Capabilities on Environmental Performance

H1: Proposed a positive direct impact of dynamic capabilities on environmental performance. The results partially support this hypothesis, indicating that reconfiguration and seizing have positive and significant impacts while sensing does not.

This suggests that not all dynamic capabilities affect environmental performance equally. Reconfiguration and seizing are particularly important for Pakistani high-tech SMEs seeking to improve environmental sustainability. However, sensing alone may not drive environmental improvements; organizations must actively reconfigure resources and seize opportunities to translate knowledge into action.

Dynamic Capabilities and Eco-Innovation

H2: Proposed a positive impact of dynamic capabilities on eco-innovation. The results show that seizing positively impacts product innovation, while sensing and seizing positively influence process innovation. Reconfiguration does not have a significant impact on either.

This highlights the importance of seizing opportunities for product innovation in the dynamic high-tech industry. Both sensing and seizing capabilities are crucial for process innovation. The lack of significance for reconfiguration suggests it may not be as critical for eco-innovation in this context.

Eco-Innovation and Environmental Performance

H3: Proposed that eco-innovation mediates the relationship between dynamic capabilities and environmental performance. The results indicate that process innovation significantly impacts environmental performance, while product innovation does not.

This suggests that internal processes and resource allocation improvements are crucial for enhancing environmental performance in Pakistani high-tech SMEs. However, while important, product innovation may not directly translate into significant environmental benefits due to consumer preferences and market conditions.

Mediating Role of Eco-Innovation

Including eco-innovation as a mediator reveals that seizing continues to have a direct positive impact on environmental performance, even when considering the indirect effect of eco-innovation. However, sensing and reconfiguration become insignificant, suggesting that they may need to be coupled with specific eco-innovation strategies to enhance environmental performance effectively.

Moderating Role of Female Executives

H4: Proposed that the presence of female executives moderates the relationship between dynamic capabilities, eco-innovation, and environmental performance. The results indicate that this moderating role is insignificant, except for a negative impact of lower-level female presence on the relationship between process innovation and environmental performance.

This suggests that the relationship between gender diversity, innovation, and environmental performance is complex and context-dependent. The negative impact of lower-level female presence may be attributed to bias, tokenism, and a lack of role models, which can hinder women's contributions to eco-innovation initiatives.

While our findings confirm female executives' statistically significant moderating effect on the relationship between eco-innovation and environmental performance,

the underlying mechanisms warrant further critical examination.

Women in executive roles may bring distinct perspectives and leadership styles that emphasize sustainability and long-term value creation (Glass, Cook, & Ingersoll, 2016). Research suggests that female leaders are more likely to champion corporate social responsibility and environmental practices due to their risk-averse, ethical, and stakeholder-oriented approaches (Post, Rahman, & Rubow, 2011; Bear, Rahman, & Post, 2010). In the context of high-tech SMEs, where flexibility and innovation are crucial, female leadership may catalyze aligning eco-innovation with environmental performance outcomes.

However, this moderating effect could be contingent on organizational culture, industry norms, and regional gender dynamics. In patriarchal or male-dominated business environments, such as those often observed in South Asian contexts, female executives might face structural barriers that limit their influence on strategic decision-making (Terjesen, Aguilera, & Lorenz, 2015). Thus, while statistically significant, the practical impact of female executives might vary depending on institutional support and inclusive governance.

The negative impact of female representation at lower levels of the executive hierarchy on process innovation and environmental performance may be particularly tied to the traditional socio-cultural order in Pakistani society. Even when women occupy executive roles, they often encounter limited access to core decision-making and restricted involvement in innovation strategy, especially in male-dominated industries. This disconnect between formal inclusion and actual influence reflects role stereotyping and potential tokenism, whereby gender diversity exists on paper but not in practice. These constraints may reduce their ability to shape innovation and sustainability outcomes, explaining the counterintuitive relationship observed. As Post et al. (2011) and Glass et al. (2016) highlight, symbolic representation does not equate to substantive influence.

Our findings contribute to a growing body of literature calling for gender-diverse leadership to drive sustainability performance (Liu, Wei, & Xie, 2014; Dadanlar & Abebe, 2018). However, the nuances in how female leadership affects environmental strategies remain underexplored, particularly in emerging economies.

Policy Implications

These findings have several policy implications:

- **Promote Reconfiguration and Seizing:** Policymakers should focus on creating an environment that supports high-tech SMEs in developing and enhancing their reconfiguration and seizing capabilities to drive environmental performance.
- **Encourage Seizing for Product Innovation:** High-tech SMEs should prioritize seizing opportunities for product innovation through market research, strategic alliances, and rapid technology adaptation.
- **Prioritize Process Innovation:** Given its significant impact on environmental performance, high-tech SMEs should focus on internal process improvements, such as adopting eco-friendly technologies and minimizing resource consumption.
- **Foster Product Innovation with Environmental Considerations:** While product innovation may not have a direct impact currently, it remains important for long-term sustainability. Policymakers can encourage the development and adoption of eco-friendly technologies and educate consumers about the environmental benefits of high-tech products.
- **Address Gender Diversity Challenges:** To fully leverage female executives' potential in driving eco-innovation and environmental performance, it is crucial to address challenges such as bias, tokenism, and lack of representation. This can be achieved through awareness campaigns, mentorship programs, and policies that promote gender equality in the workplace.

By implementing these policy recommendations, stakeholders can contribute to Pakistan's more sustainable and environmentally responsible high-tech industry.

Conclusions

Dynamic capabilities are crucial in achieving environmental performance, particularly in Pakistan's high-tech small and medium-sized enterprises (SMEs). This study explored the relationship between dynamic capabilities and environmental performance, emphasizing the role of eco-innovation and female leadership in shaping sustainable strategies.

The results indicate that seizing and reconfiguring positively influence environmental performance while sensing alone does not have a direct effect. Additionally, eco-innovation, particularly process innovation, is a key mediator between dynamic capabilities and environmental performance. Female leadership did not have a direct impact on environmental performance. However, it moderated the relationship between process innovation and environmental performance, suggesting that, under certain conditions, it can play a crucial role in fostering sustainable practices.

These findings have significant practical and policy implications. To enhance their environmental performance, high-tech firms in Pakistan should prioritize developing seizing and reconfiguration capabilities and invest in eco-innovation, particularly process innovation. At the

same time, policymakers should create supportive policies that enable businesses to integrate sustainability practices more effectively. The role of gender diversity in leadership should also be carefully considered to understand its influence on innovation and sustainability better.

Several important avenues for future research remain. A deeper examination of the roles of sensing and reconfiguration in eco-innovation could help uncover specific mechanisms that drive environmental performance. Further studies should explore how firms integrate eco-innovation within their dynamic capabilities and expand the analysis of gender diversity's impact across different organizational contexts.

One key limitation of this study is that the analysis of female executives' moderating role does not distinguish between hierarchical levels of influence or contextual authority. In traditional, male-dominated societies such as Pakistan, women in executive roles may hold nominal positions without substantial strategic input. This limitation suggests that future studies explore the presence of women in leadership and the depth of their involvement in decision-making processes. Additionally, our study does not account for the possible moderating effects of organizational culture, gender bias, or informal power structures, which could influence the observed relationship between female leadership and environmental performance. Moreover, this study's cross-sectional nature limits causal inferences. Future research should employ longitudinal data collection methods to better capture the evolution of dynamic capabilities and their impact on environmental performance over time. Additionally, qualitative methods such as interviews and case studies could provide deeper insights into the contextual factors influencing the relationship between gender diversity, innovation, and environmental sustainability. Integrating mixed-method approaches would strengthen an understanding of how firms can strategically leverage dynamic capabilities to enhance competitiveness and environmental responsibility.

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