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Why Some Firms Go Greener Than Others: The Mediating Force of Learning and the Moderating Role of Family Ownership

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Ethical Approval: The current study does not require ethical approval from any committee since the participants have not gathered sensitive information. The data collected is solely utilized for examining the **Why Some Firms Go Greener Than Others: The Mediating Force of Learning and the Moderating Role of Family Ownership**.

Informed consent. In this study, all participants completed the questionnaire after being thoroughly informed about the study's purpose. Each respondent provided explicit consent for their participation in the study.

Data Availability Statement: Data will be available upon request.

Declaration: All authors declare that they have no conflicts of interest.

Abstract
Based on the natural resource-based theory (NRBV hereafter), this study empirically investigates the impact of green technology innovation (GTI hereafter) and organizational culture (OC hereafter) on predicting green business performance (GBP hereafter) in family-owned SMEs, with the mediating role of organizational learning capability (OLC hereafter). The present study proposes the moderating role of family ownership between GTI, OC, and GP. The present study considered the SMEs currently operating in the manufacturing sector of Pakistan. SMEs were considered as units of analysis, and 411 SMEs were considered as a sample for testing of hypotheses proposed based on research questions. The empirical findings of the present study indicate that GTI, OC, OLC, and family-ownership are significantly and positively linked with the GP in case direct relationship. Moreover, the results indicate that OLC bridges the relationship between GTI, OC, and GP. In addition to that, family ownership significantly and positively influences the GP, however, it marginally moderates the relationship between GTI and GP. First, the present study contributes to existing literature in the domain of environmental performance underpinning NRBV theory in the domain of family-owned SMEs by empirically documenting the relationship between GTI, OC, and GP. Secondly, the present study is intended to contribute to underpinning theory and existing with mediating role of OLC between GTI, OC, and GP. Thirdly, the present study proposed the moderating role of family-ownership between GTI, OC, and GP in family-owned SMEs. The present study outlines the implications for managers, SMEs owners, and policymakers.
Keywords: Green Technology Innovation, Organizational Culture, Organizational Learning Capability, Green Performance, and Family-ownership.
Paper type: Research paper

1. Introduction

Post to agriculture wave, industrial revolution emerged in 19th century brought progress and offer valuable contribution to human life. Yet, this prosperity has come at the cost of environmental and resource degradation (Abbas & Dogan, 2022). Degradation of environmental and natural resources jeopardize the progress and economic growth of emerging markets and increase the vulnerability to global environment (Alkaraan et al., 2022). The surge in industrial activity has led to severe environmental pollution, prompting increased action

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through policies and consumer environmentalism (Chen & Taylor, 2020). Institutional pressures from regulatory authorities and policies and guidelines set governments to counter greenhouse gas emission and environment friendly production (Wyns & Beagley, 2021; Kumar & Barua, 2022). In addition to that, the UN introduced sustainable development goals (UN-SDGs hereafter) to improve and protect society and natural resources (UNDP, 2021). Thus, businesses started prioritizing environmental sustainability, driving them to revamp manufacturing processes, utilization of natural resources, and management frameworks (Ahmed et al., 2022). Environment friendly practices, compliance with quality standards based on updated knowledge become the key strategy to remain competitive in world businesses (Al-Qudah et al., 2022). The increasing global emphasis on environmental sustainability has compelled organizations to adopt green practices to mitigate their environmental footprint (Awan et al., 2021).

Firms' ability to acquire and retain knowledge directly impacts a company's success (Zhang et al., 2022a). Managerial abilities play a critical role in terms of acquisition and retention of green knowledge to improve customer experience, satisfaction, and improvement in various areas including the environmental, social, and economic performance (Dzhengiz & Niesten, 2020). Acquisition and utilization of green knowledge significantly improve the firm competitive position in global markets (Mohan et al., 2022). Recently literature affirmed that green knowledge management (GKM hereafter) recognized as OLC and crucial component of offering green services and products based on green processes and formulating fundamental strategies to remain competitive in global markets (Pham et al., 2022). Yet, in response to environmental challenges, innovative firms have broadened their learning capabilities from GKM by incorporating environmental considerations (Ahmed et al., 2022). The OLC significantly improves organizational efficiency and performance (Ahmed et al., 2022).

Consequently, OLC has become an essential strategic resource for many companies, helping them outperform competitors in attaining the UN-SDGs (Dang & Wang, 2022; Yu et al., 2022). The underlying objective of UN-SDGs is to ensure environment-friendly products or services through "green innovation" (Ahmed et al., 2022). In addition to that, literature affirms that innovation must focus on technological and management aspects to ensure environmental performance (Sianturi et al., 2022). The recent literature in the domain of sustainability or environmental performance documents that the key practices play a vital role towards GBP including GTI (Afum et al., 2023), OC (Abbas & Khan, 2023), green product innovation (Li et al., 2023), green process innovation (Yaroğlu, 2024), TMT attributes (Saeed et al., 2025), ownership structure (Alghawwas & Aljabr, 2025), and inter-organizational collaboration (Yasir et al., 2023). However, limited literature documents the role of GTI in predicting the GP of SMEs in the context of developing countries like Pakistan. Earlier literature affirms that SMEs in developing countries like Pakistan follow traditional practices or adopt outdated technology and fails to develop local research and development for technology innovation, considering the requirements of industry (Al-Emran & Griffy-Brown, 2023). Furthermore, the earlier literature indicates that OC in developing countries is more people-oriented (known as clan culture) because most of the SMEs are family-owned (Wijethilake et al., 2023).

Studying organizational learning and its entrepreneurial implications is particularly compelling in the context of family firms (Moser et al., 2024). Prior literature affirms that family-firms usually are willing and proactively take limited risks and are too innovative (Calabrò et al., 2019). Because of their ownership model, family involvement, and openness to risk, these firms can undertake different entrepreneurial endeavours (De Massis et al., 2021). Existing literature indicates that family SMEs may lose entrepreneurial zeal over innovation particularly while emphasizing ongoing operations and legacy of family (Liew & Loo, 2024). A key factor is that family members often monopolize decision-making and restrict information sharing, sidelining non-family members (Rosecká & Machek, 2022). This monopoly of family members significantly limits the external diverse knowledge considered vital learning and innovation.

2. Literature Review

The increasing global emphasis on sustainability has driven organizations to adopt green practices, with GTI and OC playing pivotal roles in enhancing GP. This literature review and theoretical foundation facilitates exploring the relationship between GTI, OC, and GP, focusing on how OLC mediates. Furthermore, the present study proposed that family-ownership moderates the impact of GTI, OC, on OLC and GP.

2.1 Green Technology Innovation and Green Performance

GTI refers to the development and implementation of new technologies that reduce environmental impact while improving efficiency (Chen et al., 2021). GTI significantly reduces waste reduction techniques, renewable energy solutions, and eco-friendly production processes (Kemp & Pearson, 2007; Li et al., 2023). Empirical studies suggest that GTI significantly enhances GP by reducing carbon footprints and optimizing resource use (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013). Adoption of GTI facilitates the organizations in cost saving through improved regulatory compliance and competitive advantages (Kayode-Ajala, 2023). Despite its benefits, SMEs' adoption of GTI restricted due to high initial costs, technological complexity, and resistance to change (da Silva

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et al., 2023). SMEs in developing countries need to align innovation-based strategies to attain the sustainability goals to compete in hyper-competitive international markets (Fu et al., 2021).

Studies indicate that GTI plays a crucial role in achieving sustainability goals by minimizing resource consumption and waste generation (Kemp & Pearson, 2007; Li et al., 2023). Earlier literature affirms that organizations investing in environmentally friendly innovations can lead to competitive advantage and operational efficiency through meeting the regulatory compliance and cost saving (Porter & van der Linde, 1995). Environmentally friendly technologies significantly improve waste reduction, compliance with environmental regulatory, and energy efficiency for long-term sustainability of SMEs (Horbach, 2008; Wong et al., 2020). Literature concludes based on empirical research claims that positive relationship between GTI and GP. However, recent literature affirms that the outcome can vary despite the adoption GTI depends on allocation of resources, external regulatory pressures, organizational culture or factors, management support or priorities, and ownership structure (Del Río et al., 2016). Thus, while GTI is a critical driver of GP, its impact may be contingent on other variables.

H1: Green technology innovation significantly influences the green performance of family-owned SMEs.

2.2 Organizational Capabilities and Green Performance

OC represents shared values, beliefs, and norms that influence employee behavior (Schein, 2010). A green-oriented culture prioritizes environmental responsibility and sustainability (Bai et al., 2024). A strong sustainability culture fosters employee engagement in green practices, leading to improved GP (Linnenluecke & Griffiths, 2010; Rasheed, 2025). Studies indicate that organizations with eco-friendly cultures achieve better waste management and energy efficiency (Daily & Huang, 2001; Rehman et al., 2023). Organizations actively seeking sustainable innovations were considered the proactive green culture (Abbas & Khan, 2023) and organizations response to external pressures were considered reactive green culture (Bansal & Roth, 2000; Aggarwal & Agarwala, 2022).

A green OC is one that prioritizes environmental responsibility and has been linked to higher GP (Harris & Crane, 2002; He et al., 2024). Studies suggest that OC shapes employee behaviour toward sustainability. For example, a proactive environmental culture encourages employees to engage in eco-friendly practices, such as recycling and energy conservation (Ramus & Steger, 2000; Swathi & Johnpaul, 2025). Furthermore, Linnenluecke and Griffiths (2010) found that firms with strong sustainability-oriented cultures were more likely to implement green policies effectively. The alignment between OC and corporate sustainability strategies is crucial. If employees perceive sustainability as a core value, they are more likely to support green initiatives, leading to improved GP (Norton et al., 2015; Sarwar & Shahzad, 2024).

H2: Organizational Capabilities significantly influence the green performance of family-owned SMEs.

2.3 Learning Capabilities as Mediator

Debate on OLC and its significance grown significantly among the managers, policymakers, and academic scholars to evaluate its impact on organizational performance. Existing literature affirms that OCL significantly influences organizational performance and innovation capability (Fang et al., 2011; Gomes et al., 2022). Similarly, literature asserts that organizational learning aids companies in cultivating innovations that enhance capabilities and drive performance improvements (Lopez et al., 2004; Giannakos et al., 2022). Furthermore, literature tests the mediating role of OLC and affirms that it is a possible channel through organizations can improve their efficiency (Nezam, 2023). For instance, earlier literature indicates that OLC mediates the relationship and significantly improves product development efficiency through innovation (Oyewobi et al., 2021). Similarly, Gomes and Wojahn (2017) reported that OLC is significantly and positively mediating the association with organizational performance. In addition to that, Arshad et al. (2020) demonstrated that learning ability mediated the connection between relationship capacity and SME success, shifting it from negative to significantly positive. Furthermore, the recent literature indicates that OLC indirectly influences organizational performance (Migdadi, 2021).

In contrast, limited literature claims that OLC fails to mediate the relationship between predictors and performance (Hussain et al., 2018; Lin & Huang, 2021; ShuPeng & Saibon, 2022). Earlier literature indicates the inconsistency yet, studies conclude that OLC positively influences organizational performance. In addition to that, recent literature indicates that OLC significantly improves the innovation which boosts the firm resilience which leads to organizational performance (Ahmad et al., 2018). As noted by Salisu and Abu Bakar (2020), OLC empowers companies, especially SMEs, to obtain and distribute knowledge pertinent to emerging markets, increasing profitability. Based on the above discussion the present study proposed the mediating role of OLC between GTI, OC, and GP is consistent with existing literature (Hsu & Fang, 2009; Salisu & Abu Bakar, 2020). Hence, proposed the following hypothesis:

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H3-4: Leaning capabilities significantly Mediate the relationship between green technology innovation, organizational culture, and green performance of family-owned SMEs.

2.4 Family Ownership moderator

To foster win-win scenario, the nature of family-owned business is considered key factor. From the socioemotional wealth (SEW hereafter) perspective, family firms where the owning family maintains control with a focus on generational sustainability possess unique traits, including a long-term outlook and the cultivation of intangible assets like reputation and trust in stakeholder relationships (Neubaum et al., 2012). As the definition of family firms is to extend beyond the financial results to deliver the benefits to future generations (Gómez-Mejía et al., 2007). They can also play a key role in shaping the selection, execution, and advancement of environmental initiatives, driving not just environmental benefits but also enhancing financial performance. The recent literature fails to address the impact of organizational learning capabilities on association between environmental and financial performance.

However, a limited literature earlier has demonstrated that the unique traits of family firms enhance the likelihood of environmental investments leading to better financial performance as compared to non-family firms (Craig & Dibrell, 2006; Huang et al., 2020). In addition to that ownership structure is one of the most influential factors shaping a firm's strategy and organizational performance (Grewatsch & Kleindienst, 2015). Furthermore, a few studies have examined how different types of organizational capabilities influence the relationship between environmental and financial performance (Chen et al., 2023; Eslami et al., 2024; Khan et al., 2025). The above suggestion leads to a more targeted question: 'Are the advantages of adopting green practices greater for family firms compared to non-family firms? The above discussion concludes that ownership structure acts as an internal moderating variable in the relationship between organizational capabilities and firm performance. The present study employed SEW perspective underpinning NRBV to evaluate how family vs non-family status influence the outcomes.

The relationship between GTI, OC, and OLC has gained significant attention in sustainability and management research, with recent studies exploring the moderating role of family ownership in this dynamic. GTI, driven by environmental concerns and regulatory pressures, relies heavily on an organization's ability to foster a supportive culture and continuous learning. OC, particularly one that emphasizes adaptability and environmental stewardship, can enhance innovation by encouraging risk-taking and knowledge-sharing.

H5-6: Family-ownership significantly moderates the relationship between GTI, OC, and LC of family-owned SMEs.

H7-8: Family-ownership significantly moderates the relationship between GTI, OC, and GP of family-owned SMEs.

2.5 Theoretical Foundation

The NRBV serves as the foundational theoretical framework for this study, explaining how GTI, OC, and LC contribute to GP in family-owned SMEs. To attain the sustainable competitive advantage (SCA hereafter) the NRBV outlines the foundation by leveraging valuable, rare, inimitable, and non-substitutable resources (VRIN hereafter) (Barney, 1991). This study extends RBV by integrating insights from dynamic capability theory (Teece et al., 1997) and stewardship theory (Davis et al., 1997) to contextualize the role of family ownership in sustainability. The recent literature underscores GTI's role in efficiency resources, compliance with regulations by validating its VRIN attributes (Kemp & Pearson, 2007; Horbach et al., 2012).

Variance in GP outcomes is explained by organizational capabilities with the foundation of NRBV. The current study intends to extend by proposing LC and OC as critical and social assets by extending VRIN as an intangible resource. The NRBV static focus complements family ownership as long-term stewardship. Contextualizing NRBV in sustainability, GTI, and LC to attain GP as dynamic capabilities. The NRBV augmented by dynamic capabilities and stewardship theory provides a robust lens to explain how GTI, OC, and OLC interact under family ownership to drive GP.

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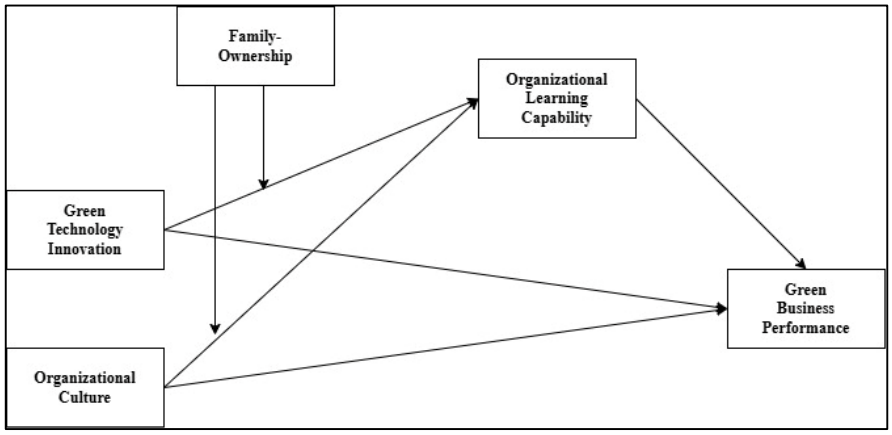

Figure 1: Theorical Framework

3. Methodology

3.1 Research Methods

Considering the empirical and theoretical gaps proposed in recent literature, the present study intends to predict GP through GTI and OC with the mediating role of LC. In addition to that, recent literature claims that ownership structure moderates the relationship between GTI, OC, LC, and GP using the partial least structure-structural equation modelling (PLS-SEM hereafter) technique. The present study intends to contribute the existing literature through empirical estimation of GTI, OC, LC, and GP with the moderating role of family-ownership using the underpinning foundation of NRBV (Cropanzano et al., 2017). The present study adapted the cross-sectional design using survey-based methods, considering the 38 items which required approximately 15 minutes to fill the survey questionnaire. The "invitation to participate" based on QR code shared through social media and email(s) to potential respondents is considered true representative of manufacturing sector SMEs, including owners, managers, and business/ marketing department managers. Participants were informed about the purpose of the study, and confidentiality was assured. No personal identifiable information was collected, and participation was voluntary; consent was obtained before data collection. Approximately 560,000 manufacturing SMEs are currently operating in Punjab, Pakistan, while in total of 800,000 manufacturing SMEs are currently registered in Pakistan (SMEDA, 2022). The present study distributed 903, considering the earlier response rate in survey-based studies. The survey questionnaire was designed to achieve a sample of 384 responses as proposed, using a simple random sampling technique (Morgan, 1970). In response, a total of 411 responses were received and considered for data analysis, with a response rate of 45.51%.

3.2 Measurement Tools

Table 1 reports the measurement of variables, including the reliability indicators Cronbach's alpha and composite reliability. The present study considered four variables, including GTI, OC, LC, and family ownership, to predict the green business performance. The present study is measuring latent variables on a 5 Likert scale from "strongly disagree" 1 to "strongly agree" 5, except for family ownership as a binary variable. The present study adapted the survey questionnaire from existing Green Business Performance (12 items) (Liu & Ren, 2022) and Organizational Culture (13 items) (Denison & Neale, 2000) demonstrate high internal consistency, with Cronbach's alpha values of 0.921 and 0.961, respectively, and composite reliability (CR) scores of 0.932 and 0.966, indicating excellent scale reliability.

Furthermore, GTI is adapted from existing literature (Wang, 2022) and measured using 5 items and learning capability was measured using 8 items adapted from (Wang, 2022), also indicating strong reliability with alpha values of 0.884 and 0.967 and composite reliabilities of 0.915 and 0.972, respectively. The alpha and composite reliability values indicate that measurement scales are consistent and dependable. Family ownership is measured as a binary variable, 0 as female and 1 as male (Tsao et al., 2015).

Table 1: Variables Measurement

Variables	Items	Mini	Max	Cronbach Alpha	CR
Green Business Performance	12	1	5	0.921	0.932
Green Technology Innovation	5	1	5	0.884	0.915
Organizational Culture	13	1	5	0.961	0.966
Learning Capabilities	8	1	5	0.967	0.972
Family Ownership	1	0	1	1	1

Source: Author's calculation

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3.3 Demographics of respondents and firms

Table 2 reports the demographic and percentage of sample demographic and frequency distribution respondents' sample of 411 participants. The first section provides key statistical measures for four continuous (or ordinal) variables which include number of employees, gender, years of experience, participant age, and firm age. The results of demographic analysis indicate that the mean value of the number of employees is 2.873 which indicates that most of respondents indicate that their company has approximately 101 to 150 employees. The standard deviation is 1.415 while the minimum value is 1 and maximum value is 5. The gender statistics indicate that the mean value of 0.491 which indicates that most of respondents are female as the present study allocate 0 for female and 1 for male. The standard deviation is 0.50 while the minimum value is 0 and maximum value is 1. The year of experience indicates the mean value of 2.925 with a standard deviation of 1.373 while the minimum value is 1 and maximum value is 5. The results indicate that most of the respondents indicate that they have approximately 21 to 30 years of experience. The mean value of participants age is 3.046 with standard deviation is 1.407 with minimum value 1 and maximum value 5. The results indicate that most of the respondents indicate that approximately their average age ranges from 40 to 50 years. The results indicate that the mean value of firm age is 3.029 with standard deviation is 1.386 with the minimum value is 1 and maximum value is 5. The results indicate that the average life expectancy of firms ranges from 21 to 30 years. The empirical findings report position category of respondents indicate 91 respondents indicate that category position as CEO which is 22.14% of total sample. In addition to that, in total 137 respondents indicate their position category as manager which is 33.33% of total sample. Furthermore, the results indicate that 183 respondents which is 44.53% of total sample.

Table 2: Demographics and percentage of the sample

	Mean	S. D	Kurtosis	Skewness	Mini	Max
No. of employees	2.873	1.415	-1.291	0.137	1	5
Gender	0.491	0.500	-2.008	0.034	0	1
Year of Experience	2.925	1.373	-1.217	0.057	1	5
Participant Age	3.046	1.407	-1.32	-0.056	1	5
Firm Age	3.029	1.386	-1.245	-0.047	1	5
Position Category					**No**	**% of Sample**
CEO					91	22.14%
Managers					137	33.33%
Business/ Marketing department manager					183	44.53%
					411	**100.00%**

Source: Author's calculation

3.4 Results of reliability and validity

The results of reliability and validity (measurement model) of latent constructs including GP, GTI, OC, OLC, and family-ownership. Reliability and validity is assessed based on items loadings (factor loading), Cronbach alpha (CA), composite reliability (CR), and average variance extracted (AVE). The present study measures the GP using 12 items and the assessment of measurement model indicates that items loadings meet the threshold value of 0.50. Prior literature affirms that threshold value of Cronbach alpha, composite reliability, and AVE as 0.70, 0.70, and respectively 0.50. The results affirm that the value of Cronbach alpha is 0.921, composite reliability is 0.932, and AVE is 0.539 meet the prior defined threshold criteria which concludes that there is no issue of convergent validity. The results of GTI indicate that item loadings meet the threshold value of 0.50. The results of Cronbach alpha are 0.884, composite reliability is 0.915, and AVE is 0.684 above the threshold value of 0.70 for Cronbach alpha and composite reliability and 0.50 for AVE. In addition to that the OC was measured with 13 items and items loadings above the threshold of 0.50. The results of Cronbach alpha are 0.961, composite reliability is 0.966, and AVE are 0.684 which above the threshold value. Furthermore, OLC is measured using the 8 items and results of items loadings above the threshold 0.50. The empirical findings indicate that the value of Cronbach alpha (0.967), composite reliability (0.972), and AVE (0.812) are above the threshold value. In addition to that, ownership is a single item construct hence item loadings, Cronbach alpha, composite reliability, and AVE is 1. The empirical findings indicate that the value of composite reliability and AVE are higher, which infers that constructs effectively capture theoretical dimensions.

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Table 3: Reliability and validity

	Loadings	Cronbach's Alpha	CR	AVE
GP_1	0.690			
GP_2	0.735			
GP_3	0.814			
GP_4	0.720			
GP_5	0.696			
GP_6	0.847	0.921	0.932	0.539
GP_7	0.815			
GP_8	0.821			
GP_9	0.852			
GP_10	0.571			
GP_11	0.621			
GP_12	0.536			
GTI_1	0.856			
GTI_2	0.856			
GTI_3	0.776	0.884	0.915	0.684
GTI_4	0.753			
GTI_5	0.887			
OC_1	0.864			
OC_2	0.875			
OC_3	0.858			
OC_4	0.871			
OC_5	0.778			
OC_6	0.836			
OC_7	0.849	0.961	0.966	0.684
OC_8	0.768			
OC_9	0.765			
OC_10	0.789			
OC_11	0.863			
OC_12	0.848			
OC_13	0.771			
OLC_1	0.917			
OLC_2	0.921			
OLC_3	0.904			
OLC_4	0.829	0.967	0.972	0.812
OLC_5	0.918			
OLC_6	0.931			
OLC_7	0.897			
OLC_8	0.889			
OWN	1	1	1	1

Source: Author's calculation

Table 4 reports the results of discriminant validity using the HTMT technique. Prior literature indicates that there are schools of thought that outline the threshold value for validation of discriminant validity. The lenient school of thought claims that the threshold value is 0.90 (Gold et al., 2001) while the strict school of thought claims threshold value is 0.85 (Kline, 2011). The results of the HTMT technique indicate that all the constructs correspond to values less than 0.85 as per the strict school of thought; however, only the corresponding value between organizational culture and green performance indicates the value of 0.893, which is above the threshold as per the strict school of thought, while less than the threshold value of 0.90. All other constructs are sufficiently distinct, confirming that they measure different aspects of the research framework.

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Table 4: Discriminant Validity

		1	2	3	4	5
1	Family-ownership					
2	Green Performance	0.642				
3	Green Technology Innovation	0.622	0.755			
4	Organizational Culture	0.507	0.893	0.630		
5	Organizational Learning Capability	0.748	0.726	0.722	0.598	

Source: Author's calculation

4. Results and Findings

4.1 Direct Relationship

Table 5 reports on the direct relationship among the latent constructs. The results indicate GTI is significantly and positively linked with GP ($\beta = 0.202$, $p < 0.001$). The empirical findings indicate that adopting GTI enhances GP outcomes with a moderate effect size ($f^2 = 0.124$). The empirical findings affirm that the adoption of GTI significantly enhances the GP of SMEs operating in the manufacturing sector of Pakistan. The OC significantly and positively influences the GP ($\beta = 0.126$, $p = 0.014$), despite the association between OC and GP indicating a smaller effect size ($f^2 = 0.055$). This implies that a sustainability-oriented corporate culture contributes to better green outcomes, but its impact is less pronounced compared to other factors in the case of SMEs operating in the manufacturing sector. The empirical findings of the present study indicate that OLC and GP ($\beta = 0.706$, $p < 0.001$), and the effect size is meaningful ($f^2 = 0.091$). The findings of the present study indicate that OLC significantly improves the GP. The results align with prior literature, which affirms that OLC significantly enhances the organizational GP (Sabir et al., 2020). This highlights that continuous learning and adaptability are critical for achieving superior environmental performance. The family-ownership indicates a significant and positive association with GP, with the largest effect size being 0.392 ($\beta = 0.336$, $p < 0.001$). This suggests that family-owned firms may be more committed to long-term sustainability goals compared to non-family businesses in the case of SMEs operated in the manufacturing sector of Pakistan. The predictive capability of the model in the case of a direct relationship among the latent constructs indicates that the value of R^2 value of 0.498 indicates that the model explains 49.8% of the variance in GP. In addition to that, the value of f-square indicates that all the latent constructs indicate a medium effect size, while family-ownership indicates the strongest effect size.

Table 5: Direct Relationship

	Coeff	S. D	T-Values	P-Values	f^2	R^2
GTI -> GP	0.202	0.042	4.846	0.000	0.124	0.498
OC -> GP	0.126	0.051	2.457	0.014	0.155	
OLC -> GP	0.706	0.139	5.079	0.000	0.191	
FO -> GP	0.336	0.049	6.913	0.000	0.392	

Note: GTI= Green Technology Innovation, GP= Green Performance, OC= Organizational Culture, OLC= Organizational Learning Capability, FO= Family-Ownership.
Source: Author's calculation

4.2 Indirect Relationship

Table 6 reports the indirect relationship of latent constructs, including GTI, OC, and GP. The GTI indicates a significant and positive association with OLC ($\beta = 0.286$, $p < 0.001$), with a medium effect size ($f^2 = 0.114$). The empirical findings indicate that GTI significantly improves the OLC of SMEs in currently manufacturing sector. The empirical findings of the present study indicate that OC significantly improves OLC at 5% level of significance ($\beta = 0.179$, $p = 0.008$), with a moderate effect size ($f^2 = 0.159$). This indicates that a supportive and adaptive culture plays a meaningful, albeit less pronounced, role in enhancing learning capabilities. The empirical findings of the present study are well aligned with prior literature, which affirms that OC significantly enhances the OLC (Al Dari et al., 2021). In addition to that, adoption of GTI and OC significantly enhances the predictive power of the model with the value of $R^2 = 0.249$, which explains the 24.9% variance in the OLC.

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Table 6: Indirect Relationship

	Coeff	S. D	T-Values	P-Values	f^2	R^2
GTI -> OLC	0.286	0.060	4.767	0.000	0.114	0.249
OC -> OLC	0.179	0.068	2.648	0.008	0.159	

Note: GTI= Green Technology Innovation, OC= Organizational Culture, OLC= Organizational Learning Capability.
Source: Author's calculation

4.3 Mediation Analysis

The NRBV and empirical literature serves the foundation, the present study proposed that mediating role of OLC between GTI, OC, and GP. Table 7 reports the mediation analysis the empirical findings of the present study indicate that OLC significantly and positively mediates the relationship between GTI and GP at 1% level of significance (β = 0.202, p < 0.001). The empirical findings of direct and indirect relationship among the latent constructs indicate a significant and positive association with GP. The positive coefficient suggests that higher levels of GTI adoption enhance OLC, which in turn improves GP. The direct and indirect relationship among the latent constructs indicates significant and positive association among the latent constructs. Hence, it reinforces the robustness of mediation path. Furthermore, the results indicate that OLC significantly and positively mediates the relationship between OC and GP (β=0.126, p = 0.014). The empirical findings indicate that in case of direct and indirect relationship indicate that OC significantly and positively predict the OLC and GP as earlier above. Hence, the robustness of results affirms that OLC partially mediates the relationship between OC and GP. The empirical findings indicate that the strong presence of OC significantly improves the OLC resultant significantly improves the GP. OLC's strong mediation (β = 0.706, *p* < 0.001) explains 49.8% of GP variance, highlighting its role in transforming GTI and OC into performance gains.

Table 7: Mediation Analysis

	Coeff	S. D	T-Values	P-Values
GTI -> OLC -> GP	0.202	0.042	4.846	0.000
OC -> OLC -> GP	0.126	0.051	2.457	0.014

Note: GTI= Green Technology Innovation, GP= Green Performance, OC= Organizational Culture, OLC= Organizational Learning Capability, FO= Family-Ownership.
Source: Author's calculation

4.4 Moderation Analysis

Prior literature affirms that family-owned firms significantly differ from non-family-owned firms in terms of organizational structure and culture, which significantly influence the firm's outcome. Hence, the present study proposed the moderating role of family ownership between GTI, OC, and OLC. Table 8 reports that it indicates that family-ownership positively yet insignificantly moderates the relationship between GTI and OLC (β = 0.078, p = 0.071). However, family ownership significantly and positively moderates the relationship at the 10% level of significance. Furthermore, the empirical findings indicate that family ownership positively yet insignificantly moderates the relationship between OC and GP. This aligns with NRBV's emphasis on resource orchestration challenges.

Table 8: Moderation Analysis

	Coeff.	S. D	T-Values	P-Values
GTI* FO -> OLC	0.078	0.043	1.803	0.071
OC*FO -> OLC	0.013	0.043	0.307	0.758

Note: GTI= Green Technology Innovation, OC= Organizational Culture, OLC= Organizational Learning Capability, FO= Family-Ownership.
Source: Author's calculation

4.5 Model Fit

The table presents goodness-of-fit indices comparing the Saturated Model (a fully specified model with all possible paths) and the Estimated Model (a theoretically constrained model) to assess how well each fits the

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observed data. The value of both metrics d_ULS and d_G indicate in case of estimated model is lower than saturated model which indicate that greater idea fit. The value of Chi-square χ^2 in case of estimated is higher than saturated model which indicate it could reduce model fit however, literature affirms that in case of large sample size estimated model can indicate a higher value. Both models show strong NFI values (Saturated: 0.938; Estimated: 0.921), exceeding the 0.90 benchmark for good fit. The last indicator for assessment of model fit rms Theta value is 0.072 which indicates that lower value or minimum residual covariance which reinforces good fit.

Table 9: Model fit

	Saturated Model	Estimated Model
SRMR	0.073	0.077
d_ULS	0.765	0.325
d_G	0.684	0.358
Chi-Square	6,762.04	7,076.46
NFI	0.938	0.921
rms Theta	0.072	

5. Discussion and Conclusions

5.1 Discussion

The findings of this study contribute to the growing body of literature in the domain of environmental performance. The present study evaluates the impact of GTI and OC on GP, mediated by OLC and moderated by family-ownership. The results align with and extend prior research while offering new insights into the dynamics of sustainability in family-owned SMEs, particularly in developing economies like Pakistan. The empirical findings of the present study claim that there is a significant and positive relationship between GTI and GP which consists of earlier literature (Kemp & Pearson, 2007; Chen & Hao, 2022). As the earlier literature affirms that adoption of GTI significantly enhances the GP through waste reduction, eco-efficient, effective, and efficient implication of environmental regulations (Martínez-Falcó et al., 2024). Despite the GTI indicating a significant and positive impact on GP, however, GTI indicates a small effect size in case of GP which indicates that complementary factors amplify its impact. The empirical findings of the present study support the NRBV which claims that sustainable competitive advantage stems from integrating innovation with organizational capabilities (McDougall et al., 2022).

In addition to that, the OC indicates a significant and positive association with GP. The findings indicate the role of shared sustainability values in driving eco-friendly practices (Ahmad et al., 2023; Rizzi et al., 2023). The empirical findings of the present study indicate the small effect size similar like GTI which acts as an enabler rather than a primary driver. The empirical findings of the present study are well aligned with prior literature which affirms that prevailing culture in organization that shapes employee behaviour but requires structural support (e.g., policies, incentives) to translate into measurable performance (Tyagi, 2021; Bourini et al., 2024; Omidvar et al., 2025). Furthermore, the findings of the present study affirm that OLC is significantly and positively linked with GP in case of direct relationship. Moreover, GTI and OC are significantly and positively linked with OLC in case indirect relationship. In addition to that, empirical findings indicate that OLC significantly and positively mediate the relationship between GTI, OC, and GP. The mediation results corroborate findings that OLC bridges innovation and performance by fostering knowledge assimilation and application (Jin & Li, 2023; Sebastian Ion & Eduard Gabriel, 2024; Hang & Meng, 2025; Le & Tuyen, 2025). The empirical findings of the present study affirms that family-ownership significantly and positively improves that OLC in the presence of GTI and OC based on the NRBV. Family firms' long-term orientation and socioemotional wealth drive investments in sustainability (Herrero et al., 2024; Rodrigues et al., 2025). However, family-ownership is marginally positive and significant which suggests that family-ownership focuses on the long-term orientation towards adoption of external knowledge for innovation to attain the sustainable performance of family-owned SMEs (De Massis et al., 2021). This duality mirrors recent debates on family firms' ambidexterity in innovation (Calabrò et al., 2019; Röd, 2019).

5.2 Conclusion

The present study provides valuable insights into the interplay between GTI, OC, and GP in family-owned SMEs, with OLC serving as a mediator and family ownership as a moderator. The result of the present study affirms that GTI and OC positively and significantly enhance GP with foundation of NRBV which claims that family-owned SMEs can attain competitive advantage from intangible organizational resources. The strong positive relationship between GTI and GP underscores the importance of adopting eco-friendly technologies to improve environmental outcomes, though the effect size suggests complementary factors are needed to maximize impact. In addition to

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that, the results of present study claim that sustainable oriented OC significantly enhances GP along with commentary technological innovation. Furthermore, the empirical findings of the present study validate the mediating role of OLC bridging GTI, OC, and GP. The results demonstrate that continuous learning and adaptability amplify the benefits of green initiatives, transforming innovation and cultural values into measurable performance gains. In addition to that, family-ownership marginally moderates the relationship between GTI, OC, and OLC reflecting the socioemotional wealth (SEW) perspective, where long-term stewardship values encourage sustainability investments but may also introduce rigidity in innovation adoption.

The empirical findings outline the practical implications for various stakeholders. The results of the present study outline the implication for managers and emphasis that manufacturing sector SMEs need to prioritize adoption of GTI can significantly foster a green OC through training and leadership alignment. The present study also outlines implications for the family-owned SMEs that focus on setting organizational culture to adopt external knowledge and technology to attain GP. The present study outlines the implications for policymakers to offer subsidies for GTI in SMEs and promote platforms for cross-industry knowledge sharing. Despite the multi-fold contributions, the empirical findings of the present study subject to number of limitations. The present study focuses on Pakistani SMEs, suggesting future cross-cultural comparisons to validate the empirical findings of the present study. The present study considered cross-sectional data which warrants longitudinal analysis to assess long-term impacts hence, future research should track GP over time to assess the sustained impact of GTI and OC. The present study considered only the manufacturing sector; hence, the future study needs to consider other sectors to validate the empirical findings of the present study.

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