Indus Journal of Social Sciences

Online ISSN: 2960-219X
Print ISSN: 2960-2203
Volume 3, Number 2, 2025, Pages 791 – 804
Journal Home Page
https://induspublishers.com/IJSS/about

Enhancing Sustainable performance in SMEs: The Moderating Role of Green Technology Capability

Asif Z. Warsi[1], Farwa Shah[2], Dr. Huma Maqsood[3] & Maryam Bibi[4]

[1]*Ph.D. Scholar, Greenwich University, Karachi. Institute of Business Management (IoBM), Karachi. Email: warsi.asif@gmail.com*
[2]*Assistant Professor, Department of Public Administration, University of Sindh, Jamshoro, Email: farwa.s.shah@gmail.com*
[3]*SZABIST University, Islamabad Campus, Email: Ch.huma.maqsood@gmail.com, huma.maqsood@szabist-isb.edu.pk*
[4]*Phd Scholar, Asia e University, Email: bibim817@gmail.com*

ARTICLE INFO

Article History:

Received:	*April*	*15, 2025*
Revised:	*May*	*20, 2025*
Accepted:	*May*	*25, 2025*
Available Online:	*June*	*03, 2025*

Keywords:

Green Absorptive Capacity, Sustainable Human Capital, Organizational Support, Green Technology Capability, Green innovation and Sustainable performance

Corresponding Author:
Asif Z. Warsi
Email:
warsi.asif@gmail.com

ABSTRACT

This study investigates the drivers of green innovation and their impact on sustainable business performance in small and medium-sized enterprises (SMEs) in Pakistan, with a focus on the moderating role of green technology capability. Drawing upon the Natural Resource-Based View (NRBV), the research conceptualizes green absorptive capacity, sustainable human capital, and organizational support as key antecedents of green innovation while positing that green technology capability enhances these relationships. The study explores the influence of green innovation on the environmental, economic, and social dimensions of sustainable business performance. Using a quantitative research design, data were collected through a structured survey from 321 managers across various SME sectors in Pakistan. Structural Equation Modeling (SEM) was employed to test the hypothesized relationships. Contrary to expectations, the results reveal that green absorptive capacity, sustainable human capital, and organization support do not significantly predict green innovation, and green technology capability does not moderate these relationships. These findings suggest that internal capabilities, while theoretically relevant, may not translate into innovative environmental practices in resource-constrained SME environments without strategic alignment and operational integration. However, green innovation was found to have a significant and positive impact on all three dimensions of sustainable performance, environmental, economic, and social, affirming its role as a critical mechanism for achieving sustainability. The study offers important theoretical contributions by challenging the generalizability of conventional green innovation models in developing economies and emphasizing the need to examine contextual and institutional dynamics. Practically, it highlights the necessity for SME leaders to go beyond capability development and focus on implementation processes, technology integration, and innovation culture to realize sustainability goals.

Introduction

Increasing environmental pressures and the need to address sustainability issues are exerting pressure on firms to implement green measures, especially SMEs, as key players in green innovation (GRIN). Green innovation specifically refers to the innovation of technology aimed at decreasing the negative effect on the environment, reducing resource waste and enhancing ecological efficiency (Chen, 2008; Zhang et al., 2019). SMEs enjoy the benefits of high flexibility and adaptability (Pilar et al., 2018). Nonetheless, the accomplishment of green practices in SMEs is hardly possible because of resource constraints and a lack of adequate knowledge. As GRIN emerges as an important prerequisite for sustainable development, the factors that influence green innovation in SMEs and the ways by which additional organizational capabilities can improve their outcomes should be well illustrated.

The findings of this research provide an understanding of the constructs that influence GRIN, including absorptive capacity, sustainable human capital, and organizational support. Innovative capability refers to the absorptive capacity, which is the ability to recognize, acquire, and exploit knowledge from outside the company's boundaries (Cohen & Levinthal, 1990). As the absorptive capacity of organizations is higher, they are in a better position to absorb and translate environmental information into green innovation (Albort-Morant et al., 2018). A fourth key driver is sustainable human capital, which would entail the integration of human resources with environmental objectives. Sustainable practices and values within employees help support green innovation as people start to incorporate sustainability into their work activities (Renwick et al., 2016). Leadership backing and resource availability for supporting green practices also helped in having an organizational environment encouraging green practices as the supportive organizational environment comes up with necessary resources and achievable goals and objectives for sustainable development (González-Benito & González-Benito, 2006).

However, these determinants may not fully explain the scope of green innovation in SMEs alone, mainly because innovation in small firms is more complex. In this regard, green technology capability, as a moderating factor, enhances the links between these determinants and GRIN. Green technology capability deals with the ability of an organization to integrate, manage, and leverage green technologies, improving absorptive capacity, human capital, and organizational support for green innovation performance. The potential of Green Technology facilitates opportunities that helps SMEs in attaining their knowledge and resources' limitations towards adopting advanced technology targeting environmental concerns and improved organizational performance (Chen et al., 2015). The moderation effect of green technology capability further adds to absorptive capacity regarding the organization's capability to obtain and utilize green technology knowledge. It may strengthen the effect of sustainable human capital by allowing workers to apply their environmental skills as intended (Qu et al., 2021).

The most important goals of this research are understanding the determinants of GRIN within the scope of SMEs, and testing the moderating role of green technology capability. Therefore, this study provides an integrated view of green innovation in SMEs by merging absorptive capacity, sustainable human capital, and organizational support, and further elucidating how green technology capability strengthens these interrelations. This research contributes significantly, both theoretically and practically, to the consideration of sustainable business green innovation, especially regarding its management dimensions for European SMEs striving for sustainable competitive advantage.

2.0 Literature review

2.1 Theory

The Natural Resource-Based View is an extension of the traditional resource-based theoretical framework outlined by Wernerfelt (1984) and Barney (1991) but put forward by Hart (1995), which explores the effector source of competitive advantage entailed by the natural environment. NRBV argues that a firm can create firm-specific assets which can create sustainable competitive advantages in environmentally supportive resources and capabilities relevant to enhanced environmental quality (Hart, 1995). Components of the NRBV include pollution control, product care, and sustainable development, all of which are directed towards the reduction of environmental effects on firm performance (Chen et al., 2014; Wang, 2019). Pollution prevention encompasses elements of operational cost reduction by helping to obtain optimum efficiency in order to minimize pollution and its effect in equal measures on costs (Hart, 1995; Qu et al., 2021). Product stewardship builds on this view, including life stream perspectives to enhance product sustainability from conception to accumulation (Hart, 1995). Sustainable development is the most elaborate type of innovation because it requires interrelated strategies for sustaining the economy as well as the environment, such as the invention of environmentally sustainable products like green technology and procurement (Teece, 2009). Research evidence demonstrates that organizations implementing NRBV practices, like green innovation, report both environmental and financial gains due to efficiency savings and increased popularity (Aboelmaged & Hashem, 2019; Shahzad et al., 2020). That is why the NRBV framework encompasses environmental responsibility with strategic management and offers a simple solution for increasing environmental demands to achieve sustainable growth for firms.

2.2 Hypotheses development

2.2.1 Green Absorptive Capacity and Green Innovation

Extending more broadly from the idea of absorptive capacity, which defined the ability of a firm to identify, acquire, and exploit extrinsic information (Cohen & Levinthal, 1990), GAC directly relates to the firm's capability for knowledge acquisition and use in support of green operations. Research undertaken previously shows that GAC is positively related to a firm's capability to put effective practices regarding environmental knowledge into practice, which will work to facilitate the uptake of eco-innovation. Through the framework of GAC, a firm is able to effectively prevent and mitigate threats emanating from the environment by integrating green knowledge and developing green innovation on new products, processes and business models (Tseng and Hung 2011).

Operation flexibility can also be posited to interact with green technology capability because the latter helps to bolster a firm's practical implementation of green knowledge to make the adoption of green innovation meaningful and significant (Chen et al., 2015). Large firms that have advancement in green technology are better placed to acquire and utilize green knowledge, given that they have the technological systems to support greens (Qu et al., 2021). This capability also enhances the GAC and green innovation link because it translates and implements the green technology into the firms' strategic and operational processes to achieve a sustainable agenda.

Hypothesis 1: *Green absorptive capacity has a positive impact on green innovation within firms.*

Hypothesis 1a: *Green technology capability positively moderates the relationship between green absorptive capacity and green innovation.*

2.2.2 Sustainable Human Capital and Green Innovation

The present sustainable human capital (SHC) means the extent to which the relevant skills, values and knowledge of the workforce are congruent with the environmental objectives of an organization to foster a workforce that is equipped for and supports the advancement of green business solutions (Renwick et al., 2016). SHC empowers employees with knowledge and interest in embracing environmentally sustainable working procedures that boost an organization's capacity for the improvement of green products, processes and practices (Wagner, 2013). Based on the literature review, there is evidence that firms that have a strong SHC enable the organization to integrate sustainability into the day-to-day operations, as Green human capital brings out positive initiatives that promote the environmental sustainability of the organization (Pava & Cho, 2012).

Green technology capability can be seen to offer a moderating influence through bridging the relationship between SHC and green innovation by allowing employees to disclose their environmental skills by relying on modern state-of-the-art green technologies." This capability enhances the quality of SHC because it gives the employees the right tools and systems to apply all the green knowledge they have to practical, creative solutions (Chen et al., 2015). The green technology capability of the firms also plays an important role in enhancing the positive impact of SHC on green innovation because the firms with high green technology capability provide facilities to their employees to implement their green skills in a better way.

Hypothesis 2: *Sustainable human capital has a positive impact on green innovation within firms.*

Hypothesis 2a: *Green technology capability positively moderates the relationship between sustainable human capital and green innovation.*

2.2.3 Organizational Support and Green Innovation

OS is the extent of the available resources, structural environment and cultural support that an organization makes available for innovation, in this case, green innovation. Culturally supportive organizational environments are instrumental in encouraging employees to carry out green activities in the organization mainly because they are provided with the needed resources and commitment from the leadership towards sustainability practices (García-Machado & Martínez-Ávila, 2019). In emphasizing that the engagement of the employees in innovation for producing environmentally sustainable solutions is critical for enhancing green responsibilities within the organization, the OS relies on dedicated resources, involving the cooperation of departments and heads, and strong leadership.

Green technology capability makes the relationship between OS and green innovation more indirect and reflects the level of required resources and infrastructure for green innovation. OS can be more beneficial to organizations that are advanced in green technology capability because such organizations can provide up-to-date green tools and technologies in support of related programs (Chen et al., 2015). In particular, when firms have expressed high levels of green technology capability, sources of organizational support were found to provide a considerably stronger and more direct input into green innovation, as green tech-savvy employees possess the technological means through which green initiatives could be realized.

Hypothesis 3: *Organizational support has a positive impact on green innovation within firms.*

Hypothesis 3a: *Green technology capability positively moderates the relationship between organizational support and green innovation.*

2.2.4 Green Innovation and Sustainable Business Performance

Green innovation (GRIN) is defined as a sustainable innovation that focuses on resolving ecological issues and generating new valuable assets for companies (Chen, 2008). GRIN actively promotes waste minimization, better resource utilization as well as low impact on the environment, making it consistent with the principles of SBP, which is a concept that gauges organizational performance in environmental, economic as well as social insets (Elkington, 1998). In this context, it can be explained that GRIN helps organizations improve their environmental impact through the exploitation of cleaner technologies and more sustainable procedures that affect environmental factors (Kammerer, 2009). In addition to this, it is agreed that GRIN promotes economic performance by decreasing costs, increasing efficiency, and brand reputation, thereby creating market competitiveness since many green users are conservation-conscious (Dangelico, 2013).

The social disposition of SBP is also affected by GRIN since firms that go green enhance the lives of their workers, create happy customers, and operate well with the community (Freeling & Mabey, 2017). Organizational benefits are realized when operational activities conform to stakeholders' demands for corporate responsibility, hence improving the image and goodwill (Mehta & Chugan, 2015). Reviewing the consequences of GRIN in relation to the environment, the economy, and society shows that the triple bottom line perspective underpins the concept, which reasons sustainable performance along these dimensions.

Hypothesis 4: *Green innovation positively impacts sustainable business performance.*

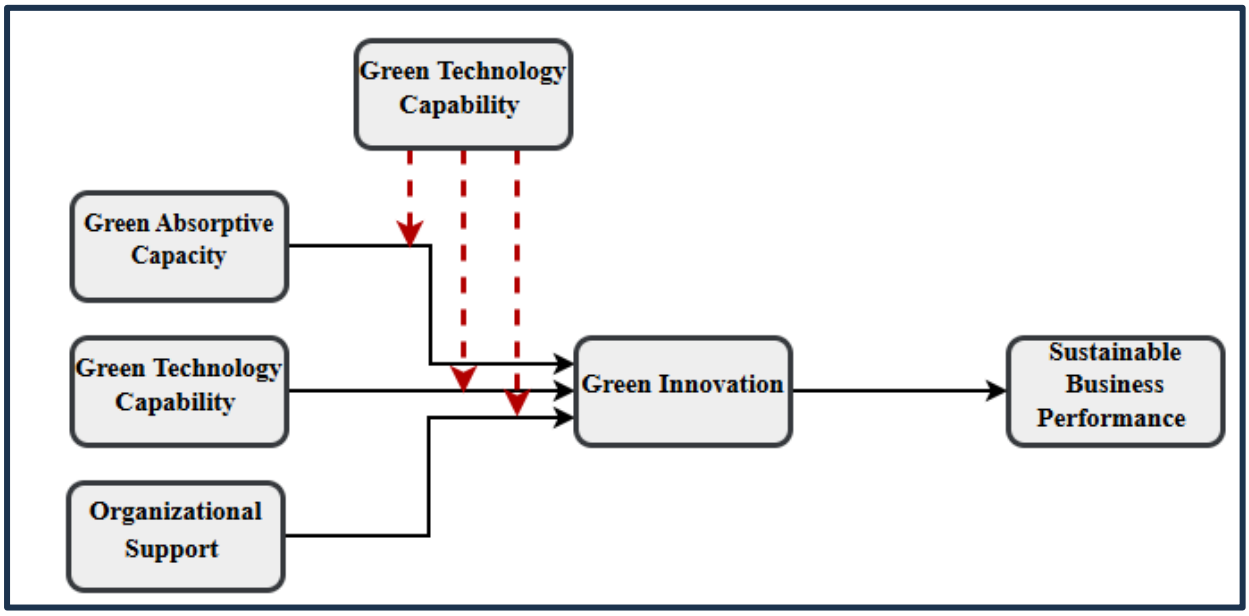

Figure 1: Research Model

3.0 Methodology

In the current study, a quantitative research approach was used to test the proposed conceptual model in the SMES sector of Pakistan. The collection of data was done in two phases. First, five managerial participants who worked in SME manufacturing concerns of Pakistan located in

Karachi and Lahore were selected for the semi-structured interview. Such interviews were important in finding out key drivers of change for green innovation (GRIN) and sustainability performance at the business level in Pakistan. From these interviews, a research questionnaire was established, which included the construct items identified in the prior studies of GRIN and sustainable performance adopted for the Pakistan market context.

Data were collected through sampling using a random probability technique, which gave every firm participating an equal likelihood of being selected. This approach made it easier to recruit diverse and balanced respondents across the construction, energy/logistics, manufacturing/IT and service industries. This survey aimed at the SMEs of Pakistan; the criterion used for the classification of firms was consistent with Pakistan's SME definition set by SMEDA, which categorizes firms with an employee strength below 250 and an annual turnover of less than PKR 1 billion. A total of 321 useful responses were collected from managers of SMEs based in Pakistan through the survey. Among these respondents, 40 per cent are from small enterprises, which were further classified as having 6-49 employees. The remaining 60 per cent are from medium enterprises, which are classified as having 50-249 employees. Some of the respondents' roles were business owners, managers, and executives. In contrast, 68 per cent of the respondents were male participants because male employees generally occupy managerial positions in most Pakistani SMEs.

3.1 Measurements

This paper focused on several constructs that captured the levels of green innovation and other factors to examine the effects of green innovation on the sustainable business performance of SMEs in Pakistan. Every construct has also been measured by a set of items with a 7-Likert response scale in which 1 stands for strongly disagree and 7 for strongly agree. The measurement items for each construct were developed from existing literature on Pakistani SMEs. In the research, the various constructs were captured on a 7-point Likert scale taken from the previous literature. According to Chen et al. (2014), Green Absorptive Capacity (GAC) consists of five items that reflect an organization's capacity to identify and utilize knowledge of the external environment. Sustainable Human Capital (SHC) developed by Chang & Chen, 2012 and Aboelmaged & Hashem, (2019) used four items to measure the investments in employee skills and sustainable development and OS developed by Jun et al. (2019). To measures the green innovation supportive human resources and reimbursement structures and is assessed with three items. Green Technology Capability (GTC) of five items measured the firm's capability to adopt and deploy green technologies. The item sample included 'We deploy technologies to minimize emissions. Green Innovation adopted from Kusi-Sarpong et al. (2015) and Aboelmaged and Hashem (2019), had four items related to environmental consciousness. Sustainable Business Performance (SBP) was measured using 9 items developed by Bansal (2005) &Wang (2019).

4.0 Results

This chapter summarizes the study's results for all the hypotheses and makes sure the measurement model is reliable and valid. First, Cronbach's alpha and composite reliability (CR) were used to measure the internal consistency of each construct, then validity was checked using Average Variance Extracted (AVE) and the Heterotrait-Monotrait (HTMT) ratio. Using Structural Equation Modeling (SEM), researchers examined the link between green absorptive capacity, sustainable human capital, organizational support, green technology capability, green innovation and sustainable performance.

4.1 Reliability statistics

Table 1: Reliability Statistics

Construct		Items	Loadings	Cronbach's Alpha	(CR)	(AVE)
Green Absorptive Capacity	5			**0.912**	**0.934**	**0.740**
		GAC1	0.857			
		GAC2	0.857			
		GAC3	0.889			
		GAC4	0.884			
		GAC5	0.812			
Sustainable Human Capital	4			**0.879**	**0.917**	**0.734**
		SHC1	0.833			
		SHC2	0.857			
		SHC3	0.838			
		SHC4	0.898			
Organizational Support	4			**0.877**	**0.904**	**0.703**
		OS1	0.885			
		OS2	0.860			
		OS3	0.785			
			0.822			
Green Technology Capability	5			**0.621**	**0.793**	**0.583**
		GTC3	0.417			
		GTC4	0.880			
		GTC5	0.894			
Green Innovation	4			**0.847**	**0.908**	**0.768**
		GI1	0.899			
		GI2	0.804			
		GI3	0.922			
Sustainable Performance	9			**0.964**	**0.969**	**0.795**
		SBP1	0.903			
		SBP2	0.909			
		SBP3	0.893			
		SBP4	0.888			
		SBP5	0.865			
		SBP6	0.918			
		SBP7	0.841			
		SBP9	0.914			

Note: Green Absorptive Capacity (GAC), Green Innovation (GI), Green Technology Capability (GTC), Sustainable Human Capital (SHC), Sustainable Performance (SP), Organizational Support (OS)

The reliability and validity statistics provided in the study confirm the internal consistency and construct validity of the key variables measured. Green Absorptive Capacity (GAC) has strong internal consistency as evidenced by a Cronbach's alpha of 0.912 and composite reliability (CR) of

0.934, suggesting that the five items such as GAC1–GAC5 are dependable constructs (Cohen & Levinthal, 1990). Sustainable Human Capital (SHC) and Organizational Support (OS) also present adequate levels of reliability with the respective values of 0.879 and 0.877 under Cronbach's alpha, thus confirming earlier studies regarding their impact in organization settings (Renwick et al., 2016; García-Machado & Martínez-Ávila, 2019). The Average Variance Extracted (AVE) for each of these constructs exceeds the 0.5 benchmark which validates convergent validity (Fornell & Larcker, 1981). Green Innovation (GI) and Sustainable Business Performance (SBP) also demonstrate strong reliability, with SBP showing an exceptionally high Cronbach's alpha of 0.964 which indicates vigorous measurement of performance across the environmental, economic, and social domains (Elkington, 1998).

Green Technology Capability (GTC) raise reliability issues due to omitting the threshold set by Nunnally & Bernstein (1994) which states that "a Cronbach's alpha below 0.70 is a reliability concern." This was evident in GTC's overall score of 0.621 and more specifically in one item (GTC3) where its loading fell below the mean value (0.417). These measurement or conceptual alignment issues explain the lack of moderation GTC had on the relationships between GAC, SHC, OS, and GI which was expected according to the theoretical model (Chen et al., 2015). All the remaining indicators are met the threshold values indicating further analysis.

4.2 Discriminant Validity

Table 2: HTMT Ratio

	GAC	GI	GTC	OS	SHC	SP
Green Absorptive Capacity						
Green Innovation	0.299					
Green Technology Capability	0.518	0.709				
Organizational Support	0.181	0.128	0.251			
Sustainable Human Capital	0.525	0.538	0.609	0.499		
Sustainable Business Performance	0.457	0.414	0.572	0.192	0.478	

Green Absorptive Capacity (GAC), Green Innovation (GI), Green Technology Capability (GTC), Sustainable Human Capital (SHC), Sustainable Business Performance (SBP), Organizational Support (OS)

The analysis of the Heterotrait-Monotrait ratio (HTMT) illustrates an acceptable level for most variable pairs, suggesting that the level of discriminant validity among the study constructs is appropriate. HTMT values under the 0.85 threshold suggest adequate discriminant validity, as specified by Henseler et al. (2015). In this research, all values exceed the threshold of 0.85, but include Green Absorptive Capacity (GAC) and Green Innovation (GI) at 0.299; GAC and Green Technology Capability (GTC) at 0.518; and Sustainable Human Capital (SHC) with GI and GTC at 0.538 and 0.609, respectively. The highest value of 0.609, observed between SHC and GTC, still is within the recommended limit suggesting these constructs are empirically distinct. These results provide evidence supporting the discriminant validity of the constructs in the structural model and validation attempt to Fornell and Larcker (1981) fostering the strength of the measurement model in Fornell and Larcker's definitional guidelines (Henseler et al., 2015).

4.3 Structural Equation Modelling

Structural Equation Modeling (SEM) is a statistical method for analyzing and evaluating intricate relations between observed values (measurable and quantifiable values) and latent variables. This technique combines factor analysis and multiple regression so that both variables and their

interconnections can be assessed simultaneously (Hair et al., 2019). SEM has significance in social science and management studies because it helps scientists test theoretical models with many different types of variables, mediators, and unobservable constructs. There are two primary types of SEM, covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). While CB-SEM is suitable for confirming theories and emphasizes fitting the model to the data, PLS-SEM is better for predictive and exploratory research, often with smaller sample sizes (Hair et al., 2011). In the study of intersection sustainability with innovation, particularly in relation to SMEs. SEM allows scholars to confirm sophisticated models such as the impact of green innovation on sustainable performance with moderation such as green technology capability. Moreover, SEM empowers researchers to evaluate rigorously the reliability and validity measurements alongside the model adequacy, thus strengthening theory-driven empirical research and tailored frameworks (Kline, 2016). Its thoroughness and agility make it indispensable for assessing multidimensional constructs in contemporary organizational research.

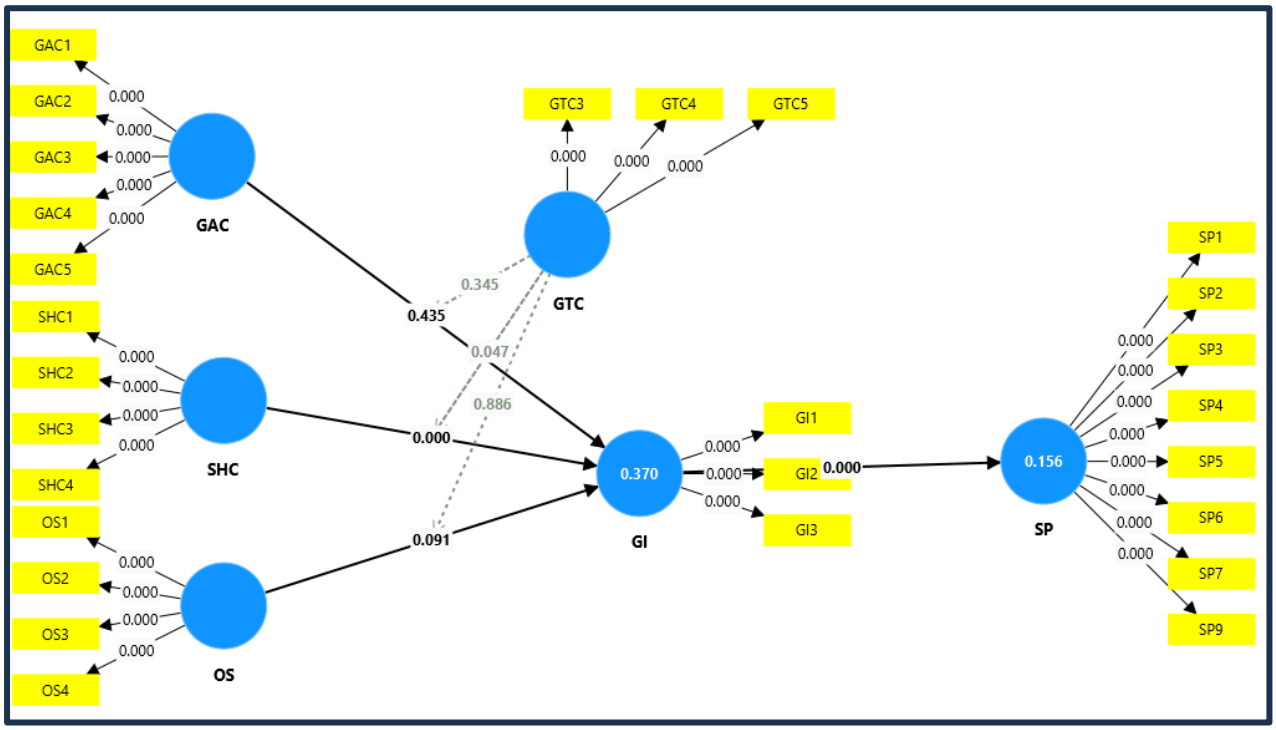

Figure 2: Structural Equation Modelling

Table 3: Results

Hypotheses	*Sample*	*(STDEV)*	*T statistics*	*P values*	*Results*
H1: GAC -> GI	-0.048	0.061	0.780	0.435	**Not Supported**
H2: GTC x GAC -> GI	0.046	0.049	0.945	0.345	**Not Supported**
H3: SHC -> GI	0.333	0.072	4.601	0.000	**Supported**
H4: GTC x SHC -> GI	-0.105	0.053	1.986	0.047	**Supported**
H5: OS -> GI	-0.092	0.054	1.691	0.091	**Not Supported**
H6: GTC x OS -> GI	0.007	0.046	0.144	0.886	**Not Supported**
H7: GI -> SP	0.395	0.052	7.643	0.000	**Supported**

The structural model results, as shown through the hypothesis testing, provide critical insights into the relationships among green absorptive capacity (GAC), sustainable human capital (SHC), organizational support (OS), green technology capability (GTC), green innovation (GI), and

sustainable performance (SP) in SMEs. Out of the seven hypotheses tested, three were supported, while four were not. Hypothesis 1, which proposed a direct positive relationship between GAC and GI, was not supported (β = -0.048, p = 0.435), suggesting that the ability of firms to acquire and apply environmental knowledge may not directly translate into green innovation in SMEs, possibly due to operational or contextual limitations. Similarly, Hypothesis 2, testing the moderating effect of GTC on the GAC–GI link, also showed no significant effect (β = 0.046, p = 0.345), indicating that even with enhanced technological capabilities, absorptive capacity alone may not drive innovation. In contrast, Hypothesis 3 was supported (β = 0.333, p < 0.001), confirming that SHC significantly influences GI. Moreover, GTC was found to significantly moderate this relationship (H4: β = -0.105, p = 0.047), although the interaction was negative, implying potential complexities or diminishing returns when high GTC interacts with SHC. Hypotheses related to OS (H5 and H6) were not supported, which may reflect structural or cultural constraints within SMEs that limit the translation of support into innovation. Finally, Hypothesis 7 was strongly supported (β = 0.395, p < 0.001), confirming that green innovation positively impacts sustainable performance across environmental, economic, and social dimensions. These results reinforce the centrality of innovation in sustainability outcomes while highlighting the need for strategic alignment and integration of internal capabilities (Hair et al., 2019).

5.0 Discussion

The last few years have seen a shift towards understanding the role of green innovation within small and medium enterprises. While SMEs are often viewed as more flexible and responsive to change, their constrained resources foster a rigidly downsized structure which makes integration of environmental considerations into business processes quite different. Firm's innovations need to navigate both internal and external factors if they are to succeed. This specific study aimed at exploring how sustainable performance is achieved by Greentech capability and what primary organizational competencies such as absorptive capacity, human capital, and supporting infrastructure motivates eco-innovations. The results deepened understanding and, to some degree, revealed the common and distinct attributes of SMEs.

Green absorptive capacity (GAC), especially within the context of green innovation in the SMEs under study, does not align with previous literature's expectations (Cohen & Levinthal, 1990; Tseng & Hung, 2011; Albort-Morant et al., 2018). Theoretically, firms with strong GAC are able to acquire and apply relevant environmental knowledge to support innovation. However, in the case of SMEs in developing countries, such as Pakistan, there seems to be a lack of infrastructure and operational preparedness to transform environmental knowledge into practical innovation. Lacking strategic implementation frameworks and commitment mechanisms renders available corporate environmental knowledge devoid of value (Hart, 1995). The limitation highlights the practical difficulties that SMEs encounter in bridging external environmental knowledge with internal processes geared toward innovation. Despite theoretical backing (Chen et al., 2015; Qu et al., 2021), green technology capability (GTC) was not found to strengthen the relationship between GAC and green innovation. The lack of moderation might suggest that technological capabilities within SMEs are either inadequately developed or not optimally incorporated into the knowledge management systems of the firm. Concerns regarding the GTC construct's reliability, reflected in low factor loadings and internal consistency, support the argument that SMEs lack the technological infrastructure needed to sustain initiatives aimed at green innovation. Such insignificant dampens the presumed synergistic effect between GAC and GTC.

This relationship was strongly supported, consistent with the literature emphasizing the role of a skilled, environmentally aware workforce in driving green innovation (Renwick et al., 2016;

Wagner, 2013). The sustainable human capital (SHC) framework arms employees with the skills, motivation, and values essential to pursue green initiatives. Given this, SHC serves as a core pillar with respect to firm-level innovation. The findings corroborate that investment in environmentally conscious human capital aids employee alignment towards developing and supporting innovative green solutions, which is in line with the Natural Resource-Based View (Hart, 1995), and emphasizes the strategic cost HR sustainability-orientated practices. The moderation, while statistically significant, demonstrated a negative direction which implies that greater amounts of GTC may weaken, rather than strengthen, the impact SHC has on green innovation. This unanticipated outcome might suggest that the implementation of technology, absent parallel integration of workforce considerations, overshadows innovation efforts driven by employee initiative. While GTC should enable SHC providing appropriate tools and infrastructure (Chen et al., 2015), a mismatch may curb frameworks bound to enhanced employee productivity. This calls for careful alignment between technological tools and human-centered innovation processes in SMEs.

Although organizational support (OS) is widely regarded as a catalyst for innovation (González-Benito & González-Benito, 2006; García-Machado & Martínez-Ávila, 2019), the study found no significant influence on green innovation. Limited formal support structures, or frameworks, in SMEs (small and medium enterprises) often offer scant informal backing. Why these organizations are innovative is often a mystery. While there may be intent behind supportive resource allocation, absent defined project goals, training, collaboration across divisions, or inter-departmental coordination, real tangible results do not occur. The lack of funding for resources in the much-needed support functions and leadership creates this resource-scaped duality akin to an innovation hunger gap. This lack of a substantive support gap alongside the symbolic support possibly explains the absence of GTC claiming moderation effects. In contrast to previously held notions where GTC strengthened the effectiveness of the organization's resources in promoting green innovation, the lack of significant interaction suggests some neglect within SMEs in supporting organizational frameworks operating in silos (Chen et al., 2015). The porous disconnect indicates minimal convergence between enabling systems and technological capacity. Without comprehensive architectural integration at the convergence of these dynamic jumping-off points, limited synergetic outcomes manifest. Poor reliability within the measuring block-conference call parameter further softens relevance toward identifying the elusive effect of moderation suggested which would otherwise pose some form of synergy. This hypothesis was strongly affirmed and aligns with the triple bottom line framework (Elkington, 1998), confirming that green innovation significantly enhances sustainability performance. Literature suggests that green innovation contributes to environmental benefits through cleaner production, economic benefits via cost efficiencies and improved competitiveness, and social benefits through enhanced stakeholder relationships (Dangelico, 2013; Mehta & Chugan, 2015). This emphasizes green innovation's pivotal role as a performance driver and validates its strategic importance in SME sustainability planning, even when internal capabilities are underdeveloped.

5.1 Limitations and Future Directions

Despite providing valuable insights into the relationship between green innovation and sustainable performance in SMEs, this study has several limitations. First, the research is limited in context as it only considers Pakistani SMEs, which could restrict the generalizability of the results to other developing or developed countries with different contextual institutions, cultures, and regulatory frameworks. Second, the ability to make causal inferences is limited because of the cross-sectional research design; capturing the passage of time in relation to the development of green innovation practices would be easier with longitudinal studies. Related to this is the concern with self-reported

survey data introducing common method bias, as answers tend to be influenced by a desire to appear favorable or inaccurate perception of reality. The reliance issues associated with measuring green technology capability raise questions about the adequacy of the available information, suggesting that moderation may have been impacted by failing to properly capture the study's core construct. Furthering this research while branching out to other countries or regions would illuminate how differing institutional settings affect green innovation within SMEs. Mixed-method or longitudinal studies could illuminate how green absorptive capacity, human capital, and organizational support resonate over time and enhance enduring sustainable performance. Moreover, this future work is crucial to faithfully operationalize the green technology capability construct as a reliable moderator by using contextual indicators directly tied to the construct. Researchers may also explore other potential moderating variables, such as environmental regulation intensity, innovation culture, or external collaboration networks, that could enhance or inhibit the impact of internal capabilities on green innovation outcomes.

References

1. Aboelmaged, M., & Hashem, G. (2019). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. *Journal of Cleaner Production, 220*, 853–863. https://doi.org/10.1016/j.jclepro.2019.02.150
2. Albort-Morant, G., Leal-Rodríguez, A. L., Fernández-Rodríguez, V., & Martínez-Román, J. A. (2018). The role of absorptive capacity and innovation in fostering organizational learning to improve firm performance. *Economic Research-Ekonomska Istraživanja*, *31*(1), 1078–1094. https://doi.org/10.1080/1331677X.2018.1436454
3. Bansal, P. (2005). Evolving sustainably: A longitudinal study of corporate sustainable development. *Strategic Management Journal*, *26*(3), 197–218. https://doi.org/10.1002/smj.441
4. Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108
5. Chang, C.-H., & Chen, Y.-S. (2012). The determinants of green intellectual capital. *Management Decision*, *50*(1), 74–94. https://doi.org/10.1108/00251741211194886
6. Chen, Y.-S. (2008). The driver of green innovation and green image – Green core competence. *Journal of Business Ethics, 81*(3), 531–543. https://doi.org/10.1007/s10551-007-9522-1
7. Chen, Y.-S., Chang, C.-H., & Lin, Y.-H. (2014). Green transformational leadership and green performance: The mediation effects of green mindfulness and green self-efficacy. *Sustainability*, *6*(10), 6604–6621. https://doi.org/10.3390/su6106604
8. Chen, Y.-S., Chang, C.-H., & Lin, Y.-H. (2015). The determinants of green radical and incremental innovation performance: Green shared vision, green absorptive capacity, and green organizational ambidexterity. *Sustainability*, *7*(11), 15342–15361. https://doi.org/10.3390/su71115342
9. Chen, Y.-S., Lin, M.-J. J., & Chang, C.-H. (2014). The influence of environmental friendliness on green trust: The mediation effects of green satisfaction and green perceived quality. *Sustainability*, *6*(9), 6632–6649. https://doi.org/10.3390/su6096632
10. Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152. https://doi.org/10.2307/2393553
11. Dangelico, R. M. (2013). Green product innovation: Where we are and where we are going. *Business Strategy and the Environment*, *25*(8), 560–576. https://doi.org/10.1002/bse.1886
12. Elkington, J. (1998). *Cannibals with forks: The triple bottom line of 21st century business*. New Society Publishers.

13. Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.2307/3151312
14. Freeling, N., & Mabey, C. (2017). *Green HRM and employee well-being: A closer look at how environmental initiatives affect work and life*. Greenleaf Publishing.
15. García-Machado, J. J., & Martínez-Ávila, M. (2019). Environmental performance and green culture: The mediating effect of green innovation. *An International Journal of Corporate Social Responsibility*, *5*(1), 1–13. https://doi.org/10.1186/s40991-019-0043-8
16. González-Benito, J., & González-Benito, Ó. (2006). A review of determinant factors of environmental proactivity. *Business Strategy and the Environment*, *15*(2), 87–102. https://doi.org/10.1002/bse.450
17. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2019). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). SAGE Publications.
18. Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review*, *20*(4), 986–1014. https://doi.org/10.5465/amr.1995.9512280033
19. Jun, W., Ahmad, N. H., Wilson, C., & Noor, N. A. M. (2019). Linking green HRM practices to environmental performance through pro-environmental behavior in the Malaysian manufacturing sector. *Resources, Conservation and Recycling*, *148*, 144–154. https://doi.org/10.1016/j.resconrec.2019.05.030
20. Kammerer, D. (2009). The effects of customer benefit and regulation on environmental product innovation: Empirical evidence from appliance manufacturers in Germany. *Ecological Economics*, *68*(8–9), 2285–2295. https://doi.org/10.1016/j.ecolecon.2009.02.016
21. Kusi-Sarpong, S., Gupta, H., & Sarkis, J. (2015). A supply chain sustainability innovation framework and evaluation methodology. *International Journal of Production Research*, *54*(21), 1–20. https://doi.org/10.1080/00207543.2015.1099501
22. Mehta, M. C., & Chugan, P. K. (2015). Corporate environmental responsibility: A strategy for sustainable development. *International Journal of Research in Commerce, IT & Management*, *5*(2), 55–60.
23. Pava, M. L., & Cho, C. H. (2012). *Research in corporate social performance and policy: Vol. 1. The value and use of social reporting information* (Emerald Group Publishing Limited). https://doi.org/10.1108/S1479-3563(2012)0000004009
24. Pilar, L. V., Rosa, Á. A., Figueiredo, R., & Freitas, H. M. R. (2018). Green innovation in small and medium-sized enterprises: A case study from the automotive sector. *Journal of Cleaner Production*, *204*, 626–639. https://doi.org/10.1016/j.jclepro.2018.09.031
25. Qu, Y., Liu, Y., & Chen, H. (2021). Green dynamic capabilities, green innovation and green performance: Evidence from Chinese manufacturers. *Journal of Cleaner Production*, *306*, 127134. https://doi.org/10.1016/j.jclepro.2021.127134
26. Renwick, D. W. S., Redman, T., & Maguire, S. (2016). Green human resource management: A review and research agenda. *International Journal of Management Reviews*, *18*(1), 15–45. https://doi.org/10.1111/ijmr.12000
27. Shahzad, M., Qu, Y., Zafar, A. U., Rehman, S. U., & Islam, T. (2020). Exploring the role of employee green behavior towards environmental performance of green hotel: Underlying mechanism of green HRM and psychological green climate. *International Journal of Manpower*, *41*(7), 1035–1054. https://doi.org/10.1108/IJM-08-2019-0400
28. Teece, D. J. (2009). *Dynamic capabilities and strategic management: Organizing for innovation and growth*. Oxford University Press.
29. Tseng, S.-M., & Hung, S.-W. (2011). A framework identifying the gaps between customers' expectations and their perceptions in green products. *Journal of Cleaner Production*, *59*, 174–184. https://doi.org/10.1016/j.jclepro.2011.07.023

30. Wagner, M. (2013). 'Green' human resource benefits: Do they matter as determinants of environmental management system implementation? *Journal of Business Ethics*, *114*(3), 443–456. https://doi.org/10.1007/s10551-012-1356-9
31. Wang, Y. (2019). Environmental orientation, green supplier selection and green innovation: The mediating role of environmental capabilities. *Sustainability*, *11*(5), 1227. https://doi.org/10.3390/su11051227
32. Wang, Y. (2019). Linking green strategy, green human resource management, and green innovation: Evidence from Chinese manufacturing firms. *Sustainability*, *11*(20), 5404. https://doi.org/10.3390/su11205404
33. Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171–180. https://doi.org/10.1002/smj.4250050207
34. Zhang, Y., Yang, L., & Wang, Y. (2019). Green innovation and firm performance: Evidence from listed companies in China. *Resources, Conservation and Recycling*, *144*, 48–55. https://doi.org/10.1016/j.resconrec.2019.01.023