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KEYWORDS	ABSTRACT
technology innovation capability; green dynamic capabilities; sustainable performance; SMEs; PLS-SEM; Khyber Pakhtunkhwa	Small and medium enterprises (SMEs) in Khyber Pakhtunkhwa face increasing pressure to improve their sustainable performance while maintaining profitability. However, translating technological capabilities into sustainable outcomes remains a challenge for many SMEs. Based on the resource-based view and dynamic capabilities theory, the study explores the intervening role of green dynamic capabilities (GDCs) between technology innovation capability (TIC) and sustainable performance (SP). A total of 312 SME owners and managers were surveyed and analyzed using partial least squares structural equation modeling (PLS SEM). The results reveal that TIC positively influences SP ($\beta = .430, p < .001$) and GDCs ($\beta = .252, p < .001$). GDCs also positively influence SP ($\beta = .374, p < .001$). Additionally, the indirect effect of TIC on SP via GDCs is positive and significant ($\beta = .094, p < .001$), providing complementary partial mediation. The findings indicate that the technology innovation capabilities indirectly affect sustainable performance by creating green dynamic capabilities and directly affect by sustainable performance. Therefore, the sustainable performance of SMEs can be improved if they are able to develop and reconfigure their resources and processes to meet environmental challenges alongside their technological capacity. This research has revealed that the green dynamic capabilities play a significant role in the explanation of how technological innovation capabilities can translate into sustainable performance of SMEs
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Introduction and Background

Small and medium enterprises (SMEs) play a significant role in the economic development, employment creation and regional competitiveness. The significance of their role is most pronounced in emerging economies like Pakistan, where SMEs mostly faces resource constraints and are

increasingly technological, market, and environmental pressures (Chaudhry, 2000; Manzoor, Wei, & Siraj, 2021). In Khyber Pakhtunkhwa, SMEs contribute to local economic activity in form of manufacturing, services, trade as well as emerging technology-based sectors. However, these firms face growing environmental pressures while striving to maintain productivity and competitiveness. Therefore, technological advancements and sustainability have thus become closely related strategic issues. Since, technological innovation helps SMEs improve production efficiency, reduce resources consumption, design and build new products and responds to evolving expectations of customers and the environment (Ahmad & Khan, 2025; Chege & Wang, 2020). Meanwhile, sustainability required firms to acquire and develop skills needed to provide a balance of economic performance, environmental and social responsibilities. The latest literature on Pakistani SMEs advocates that capability development has a crucial role in strengthening the innovation capability, thereby enhancing the firm performance in resource constrained environments (Khan et al., 2023).

Technology innovation capability (TIC) is the ability of the firm to acquire, combine, use and continually update and enhance its technological knowledge and resources (Garcia & Calantone, 2002). This capability can offer SMEs opportunities to develop novel products, enhance production processes, minimize operational waste, and use more environmentally friendly production methods. Technology can also help with information management and enable firm to respond to evolving market conditions (Saeed et al., 2025). The research conducted in Pakistan indicates that technological orientation and innovation in products can positively impact organizational performance, highlighting the role that technological capabilities in SMEs (Tariq et al., 2021). Likewise, there is growing evidence showing the association amongst Industry 4.0 technologies and organizational innovation with Sustainable Performance (SP) (Farrukh et al., 2025). These results highlights, TIC as a significant factor for sustainability of the firms, as it helps in increasing their operational efficiency and environmental performance.

Nevertheless, the possession or adoption of technology alone may not be sufficient to produce sustainable outcomes. SMEs also need to have the organizational capacity for sensing and seizing environmental opportunities, organizing technological resources and adapting existing routines to address sustainability issues (Jie, Gooi & Lou, 2025). This issue reveals a significant gap in the existing literature. The extant research mostly emphasizes on technology innovation, green innovation, dynamic capabilities and sustainability as relatively separate fields of study. However, less effort has been directed towards the organizational mechanism that translates TIC into enduring performance. Especially, the role of green dynamic capability (GDC) as an intermediate mechanism is not well explored in the emerging economies especially in SMEs.

GDC refers to the capability of a firm to integrate, develop, and reconfigure its resources and processes to respond to environmental dynamics and sustainability outcomes (Lin & Chen, 2017). They extend the broader notion of dynamic capabilities and focus on environmental goals and green transition. GDCs help companies identify environmental opportunities, adapt to environmental pressures, and restructure resources to focus on green innovation and sustainability practices. Recent literature highlights that green capabilities may reinforce the link amongst innovation and

sustainability by facilitating the translation of resources and knowledge into sustainable results (Rahman et al., 2025; Weber et al., 2025). Additionally, empirical evidence from Pakistan suggests that organizations with dynamic sustainable capabilities perform better in environmental and social dimensions, underlining the significance of organizational adaptation in attaining sustainability (Khaskheli et al., 2022). Following these arguments, the present research conceptualizes GDCs as a mediating mechanism amongst TIC and sustainability. The rationale is that technological innovation capability gives SMEs technological resources and knowledge that can be used for sustainability. However, these resources are more likely to have a meaningful sustainability impact when companies have the capability to reconfigure the resources in response to environmental requirements (Abid et al., 2023). TIC can, therefore, affect sustainability in two ways. First, it can have a direct impact by optimizing resource use, technological problem solving, product development and operational performance. Secondly, it has an indirect role, by enhancing GDCs, enabling SMEs to transform technological resources into sustainable outcomes and environmental responsibilities.

The Resource Based View (RBV) and Dynamic Capability Theory provide theoretical foundation for the proposed model (Priem & Butler, 2001; Wang & Ahmed, 2007). According to RBV, business enterprises can achieve competitive advantage by possessing valuable and hard-to-imitate resources and capabilities. In this sense, TIC is a strategic organizational resource that can help SMEs to create novel solutions and enhance the performance of their operations. But the value of technology lies in the ability of the firm to combine it with knowledge, managerial skills, routines, and complementing capabilities. GDC are thus especially relevant since they shape the potential for the use of technological resources for environmental goals. A complementary explanation is offered by DCT, focusing on a firm's ability to sense changes, seize emerging opportunities and transform the resource base. Sustainability is a dynamic landscape where customer preferences, environmental laws and protocols, technology, resources, and competition are all in flux. SMEs need, therefore, not only to have technological resources, but to constantly reshape and rearrange them. This adaptive mechanism is offered by the GDCs; the alignment of technological innovation and the evolving environment requirements. The theoretical perspective is especially useful for SMEs in KP, as they are limited in their financial and technological resources, requiring them to effectively combine and reconfigure existing capabilities.

Therefore, the analysis of GDCs as a mediator offers a more holistic understanding of how SMEs can convert technology innovation into sustainability. The framework supports sustainability research by linking technological capability with the organizational processes necessary to create sustainable outcomes. It also expands the use of RBV and Dynamic Capability Theory to a little-researched regional context and an emerging economy. The study can help practitioners understand the need for managerial skills to be developed that are green in addition to investments in technology. For policy makers it can offer information on the kind of capability development that can facilitate the uptake of sustainable technologies by SMEs. Thus, the present study aims to explore the association amongst TIC and sustainability of the SMEs in Khyber Pakhtunkhwa, Pakistan by determining the mediating role of GDC. The study seeks to determine whether technological

capability contributes directly to sustainability and whether this relationship is strengthened through firms' ability to develop and reconfigure green-oriented resources and routines.

Theoretical framework

The model is based on two related theories. The first is the RBV, suggesting that firms are able to obtain a sustained competitive edge by possessing resources and capabilities that are valuable, rare, difficult to imitate and well organized. The RBV model is widely employed in SME research to illustrate how the same factors, such as the use of inputs, can lead to a significantly different outcome (Alraja et al., 2022). TIC fits this description well. It has been developed over the years through learning, experimenting and staff skills and is not something that can be bought off the shelf. The RBV, however, has a very limited dynamic. It provides an understanding of the value of a capability but is less informative in terms of the capability's ongoing relevance to market and regulatory evolution and customer expectations. Dynamic capabilities theory provides a framework to address this gap. It refers to the high-order processes by which organizations discover new opportunities, capture them through investment and decision-making and adapt their resource base (Taghizadeh et al., 2024). Recent studies reveal that these practices are equally applicable to small firms and large enterprises, although they are typically more informal and closely linked to the owner or manager in SMEs (Niamat & Qureshi, 2025).

GDC extends this logic to environmental concerns. They reflect a firm's ability to monitor environmental developments, acquire and absorb green knowledge from partners and markets, and integrate that knowledge into new processes and products (Ahmad et al., 2025; Qiu et al., 2020; Yousaf, 2021). The natural-resource-based view, linking competitive advantage to a firm's connection with the natural environment, further support this notion (Andersén, 2021). Taken together, these perspectives suggest a sequence. TIC is a valuable resource (RBV). Its value for sustainability depends partly depends on how effectively it supports green sensing, learning and reconfiguration routines (dynamic capabilities). The term "orchestration" in this study's title refers to this process of combining and directing capabilities so that they produce environmental, social and economic results together. Figure 1 presents the resulting model.

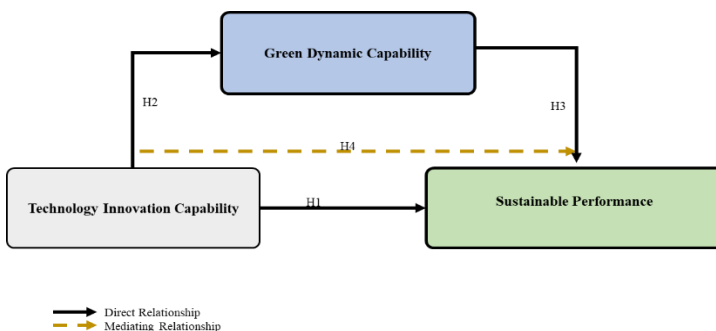


Figure 1. Conceptual model. TIC is expected to raise SP directly (H1) and indirectly by strengthening GDC (H2, H3, H4).

Technology innovation capability and sustainable performance

TIC is the competency of a company to acquire, develop, and adapt technologies to enhance processes and products. Companies with good TIC are often better equipped to use efficient equipment, re-engineer production activities to minimize scrap and rework, and launch new products that comply with increasingly stringent quality and safety requirements. These results are suitable for various aspects of SP. For instance, lower material and energy use can lead to decreased production costs and emissions and better working conditions through safer production processes. Likewise, better products can help improve customer relationships, improve market competitiveness, and aid in long-term firm performance.

The empirical evidence from SMEs confirms that technology innovation has a positive relationship with SP in general. Alraja et al. (2022) reported that SMEs SP was associated with technological innovation, partly via green practices. Likewise, Taghizadeh et al. (2021) showed that technology capability positively affected the operational performance of Malaysian SMEs by enabling open innovation. Additionally, studies of manufacturing companies reveal that technology can facilitate green innovation, which can enhance a company's environmental performance by allowing them to create cleaner products and processes (Rehman et al., 2021). These findings are particularly relevant to SMEs in Khyber Pakhtunkhwa, where high energy costs and unreliable energy supply can increase operating pressures. Therefore, technologies that save energy and raw materials might provide environmental and economic gains for such firms. Based on this, the first hypothesis is proposed that:

H1: TIC has a positive effect on the SP of SMEs.

Technology innovation capability and green dynamic capabilities

Companies that have more technological resources are also likely to be better able to identify and react to environmental opportunities. This relationship can be explained by the overlap between technological and dynamic organizational routines. For instance, the constant monitoring of new technologies can alert managers to cleaner production options. Likewise, working with the adaptation of technological equipment can enhance their problem-solving abilities in redesigning processes and minimizing waste. As well as being able to acquire and apply new green knowledge, technical employees who regularly learn from suppliers, customers and partners from outside may also be better suited to develop their new green knowledge. TIC can thus enhance a firm's dynamic capabilities to sense and seize environmental opportunities.

This relationship is supported by the concept of absorptive capacity. It is found that firms with more technological knowledge are better equipped to identify, incorporate and utilize third-party knowledge, encompassing knowledge on environmental technologies and environmental regulations (Shahzad et al., 2020). GDC are also closely linked with the capacity of the firms to create green products and engage in green innovation, as shown by Qiu et al. (2020). This process will probably continue to rely on some extent on the technological expertise and capacities currently

accessible to the company. Additionally, evidence from Pakistani SMEs indicates that firms with higher capability bases have a superior ability to engage in eco-innovation even under resource constraints (Niamat & Qureshi, 2025). Therefore, TIC can be considered as a key enabler for building green dynamic capabilities. Therefore, it is hypothesized that:

H2: TIC positively influences the GDC of the SMEs.

Green dynamic capabilities and sustainable performance.

GDC help firms adapt their environmental practices over time in response to the evolving market, technology, regulatory and stakeholder demands. Early recognition of emerging environmental trends can enable firms to re-position their products before regulatory requirements increase or customer preferences change. Firms that are able to access and utilize green knowledge are also in a better position to implement cleaner production processes, waste reduction and better resource utilization. The flexibility to rearrange organizational routines also helps firms adjust to environmental and economic shocks like sudden energy price hikes without adversely impacting their performance. These capacities can directly contribute to better environmental performance, as well as to economic benefits via cost savings, participation in green markets, and corporate reputation.

This correlation is supported by empirical evidence in previous studies. Through green practices and value co-creation, GDC were found to be contributing to the green innovation (Yousaf, 2021). Similarly, Qiu et al. (2020) discovered that there is a positive correlation between green dynamic capability and competitive advantage in manufacturing firms. Likewise, Mady et al. (2023) showed that sustainable competitive advantage of manufacturing SMEs through the pathway of eco-innovation was supported by the internal environmental capabilities. In general, studies on green innovation have found positive associations between green innovation and corporate SP and environmental outcomes (Kraus et al., 2020; Wang et al., 2021). Together, these results indicate that GDC can facilitate the transformation of environmental knowledge and resources into practices that can help firms achieve both ecological and economic goals. Based on this, the following hypothesis is proposed:

H3: GDC have a positive effect on the SP of SMEs.

The mediating role of green dynamic capabilities

The preceding arguments imply that GDC sits between TIC and SP in a causal chain. Technology capability gives a firm the raw material for change, while GDC direct that material toward environmental and social goals. Without such capabilities, technology may improve efficiency but leave environmental opportunities unexplored; with them, technical skills are repeatedly redeployed toward greener processes, products and relationships.

This “capability conversion” view is supported by research showing that green practices and green innovation often transmit the effects of broader resources onto sustainability outcomes. Alraja et al. (2022) found that sustainable green practices acted as the process through which technological factors shaped SP. Shahzad et al. (2020) showed that green innovation carried the effect of knowledge management onto corporate SP. Mady et al. (2023) reported a similar mediating role for eco-innovation in SMEs. Because TIC is also expected to influence SP through other channels, such as productivity gains unrelated to the environment, partial rather than full mediation is expected. The fourth hypothesis is:

H4: GDC mediate the relationship between TIC and SP.

Methods

Population and sample

The target population was registered manufacturing, trading and service SMEs in Khyber Pakhtunkhwa, defined in line with the National SME Policy as firms with up to 250 employees (SMEDA, 2021). A sampling frame was compiled from member lists of the Sarhad Chamber of Commerce and Industry and district chambers in six districts with the highest concentration of SMEs. Because the frame did not record firm size reliably, proportionate stratified sampling by district was combined with screening questions on employee numbers. Firms with fewer than 10 employees were excluded, since micro-enterprises rarely have formal technology or environmental routines.

Owners, managing directors and senior managers were chosen as key informants because they are best placed to judge firm-level capabilities and performance. Of 450 questionnaires distributed in person and online over 10 weeks, 336 were returned and 312 were complete and usable, a usable response rate of 69.3%. This exceeds the minimum of 155 suggested by an inverse square root calculation for detecting path coefficients of 0.20 at the 5% level (Hair et al., 2022). Table 1 summarises the sample profile.

Table 1. Profile of responding SMEs (N = 312)

Characteristic	Category	Frequency	Percent (%)
Industry sector	Manufacturing	120	38.5
	Services	81	26.0
	Wholesale and retail trade	60	19.2
	Agro and food processing	32	10.3
	Information and communication technology	19	6.1
Firm age in years	Less than 5	48	15.4
	5 to 10	103	33.0
	11 to 20	112	35.9
	More than 20	49	15.7
Number of employees	10 to 49	174	55.8

Characteristic	Category	Frequency	Percent (%)
District	50 to 99	79	25.3
	100 to 250	59	18.9
	Peshawar	98	31.4
	Mardan	52	16.7
	Haripur (Hattar)	47	15.1
	Swat	41	13.1
	Abbottabad	39	12.5
	Nowshera	35	11.2
Respondent position	Owner or managing director	141	45.2
	General manager	97	31.1
	Production or operations manager	74	23.7

Questionnaire development

All constructs were measured with multi-item scales. The response was on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). TIC was measured by nine items from Lee et al. (2014). The items show a firm's ability to learn, transform and innovate technologies. They also explain how firms use these technologies in their products and production processes. Five items adapted from the Bağış et al. (2016) were used to measure GDCs. It measures the capacity of a firm to monitor environmental changes, acquire green knowledge and reconfigure resources to meet environmental needs. The 6 items adapted from Alraja et al. (2022) were used to measure SP. Each of the three dimensions (economic, environmental and social) was represented by two items. The three dimensions were defined as a single reflective dimension representing overall SP. The control variables used in the SP analysis were firm age, firm size and industry sector.

Data analysis

Partial least squares structural equation modeling (PLS-SEM) was used to estimate the proposed model in SmartPLS 4 (Ringle et al., 2024). This decision was made for two reasons. The study is designed to predict and explain relationships between constructs. It also assesses a mediating mechanism in the form of green dynamic capabilities. Furthermore, PLS-SEM is very useful if the data used are multivariate and non-normal (Hair et al., 2022; Sarstedt et al., 2022).

The analysis was carried out using the two stage PLS-SEM procedure (Becker et al., 2023). The first stage was an evaluation of the measurement model. This stage validated reliability and validity of all constructs. It addressed the reliability of the indicators, the internal consistency reliability, validity for convergence, and validity for discrimination. The second phase was used for the structural model evaluation. Collinearity, significance and size of hypothesized path coefficients, explained variance and predictive relevance were used. The indirect path of TIC to SP mediated by GDCs was examined. Direct and indirect effects were tested using 5,000 replications of bootstrapping. To establish statistical significance, percentile-based confidence intervals were

computed. This method provided a strong test for the hypothesized relationships and the mediation of green dynamic capabilities.

Results

All four hypotheses were supported, and GDC carried about half of the total effect of TIC on SP. The sections below follow the standard PLS-SEM reporting order: common method bias, measurement model, then structural model.

Assessment of common method bias

Because each questionnaire was completed by a single respondent at one point in time, CMB was a potential concern (Podsakoff et al., 2024). Procedural remedies were applied before data collection: respondents were assured of anonymity, the predictor and outcome items were placed in separate sections with different instructions, and items were worded neutrally to reduce social desirability.

Two statistical checks followed. First, Harman's single-factor test showed that one unrotated factor explained 31.8% of the total variance, well below the 50% threshold. Since this test is known to be weak on its own (Kock, 2021), a full collinearity assessment was also run by regressing a random variable on all latent constructs. The resulting variance inflation factors were 1.64 for TIC, 1.88 for GDC and 1.76 for SP, all below the conservative cut-off of 3.3 (Kock, 2021). Taken together, these results indicate that CMB is unlikely to bias the findings.

Measurement model assessment

Factor loadings, reliability and convergent validity

Table 2 shows the measurement model assessment results of indicator loading, indicator significance, VIF, internal consistency reliability, and convergent validity for the GDC, SP, and TIC.

The results show that all the indicator loadings are above the recommended value of .70, ranging from .742 to .860 for GDC, .775 to .868 for SP and .759 to .844 for TIC. The values indicate that the indicators have good representation of the constructs they are measuring. Moreover, all t statistics are greater than 1.96 suggesting the indicator loadings are significant at $p < .001$. Therefore, the reliability of all the indicators is satisfactory and they all measure the constructs they represent well. Cronbach's alpha is .871 for GDC, .901 for SP, and .933 for TIC with regard to internal consistency reliability. Likewise, the composite reliability values are .907, .924 and .944 respectively. All of these values are above the recommended .70 internal consistency reliability point for all three constructs, indicating that the internal consistency reliability is satisfactory. AVE was used to measure convergent validity. Each of the AVE values are above the recommended minimum value of 0.50: .661 for GDC, .670 for SP, and .652 for TIC. The above results demonstrate the constructs account for more than 50% of the variance in their indicators, thus convergent validity. Lastly, the VIF values are between 1.636 and 2.801, which is less than the conservative threshold considered as

3.3. This suggests that no multicollinearity among indicators is likely to be a major issue. Further, discriminant validity was also established as seen in Table 3.

Table 2: Reliability and Validity

Variable		Indicator	Loading	T Stats	VIF	Cronbach's Alpha	Composite Reliability	AVE
Green Dynamic Capability		GDC1	0.742	25.188	1.636	0.871	0.907	0.661
		GDC2	0.809	35.000	1.918			
		GDC3	0.828	40.587	2.053			
		GDC4	0.860	59.638	2.365			
		GDC5	0.822	42.908	2.074			
Sustainable Performance		SP1	0.775	33.494	1.862	0.901	0.924	0.67
		SP2	0.810	40.413	2.154			
		SP3	0.832	42.259	2.344			
		SP4	0.868	57.182	2.714			
		SP5	0.791	34.833	1.944			
		SP6	0.832	44.089	2.290			
Technology Innovation Capability		TIC1	0.783	37.450	2.188	0.933	0.944	0.652
		TIC2	0.759	28.140	1.983			
		TIC3	0.828	43.935	2.512			
		TIC4	0.785	33.364	2.098			
		TIC5	0.832	44.686	2.598			
		TIC6	0.844	48.361	2.801			
		TIC7	0.782	35.893	2.121			
		TIC8	0.820	43.917	2.528			
		TIC9	0.830	50.495	2.583			

Table 3: Discriminant Validity

	Fornell and Larcker			HTMT Ratio		
	GDC	SP	TIC	GDC	SP	TIC
GDC	0.813					
SP	0.482	0.819		0.542		
TIC	0.252	0.524	0.807	0.277	0.57	

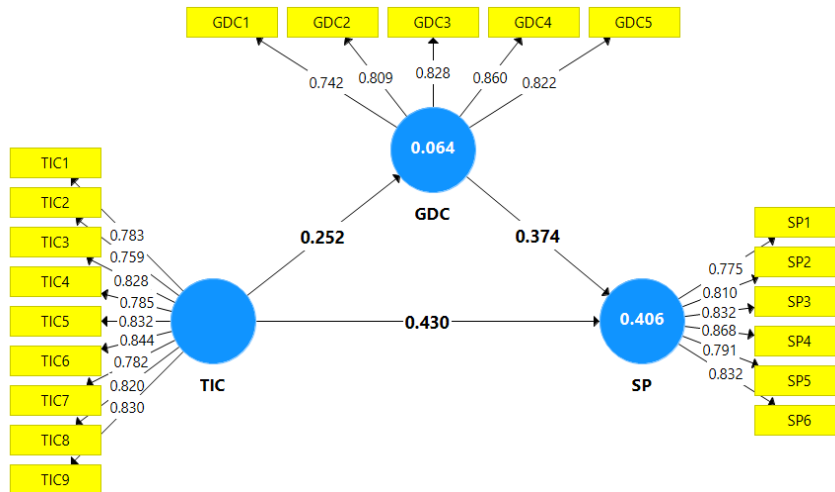


Figure 2: Measurement Model; Source: Author

Structural model results

Before testing the hypotheses, collinearity among predictors was checked. The inner VIF for TIC and GDC as predictors of SP was 1.51, well below the threshold of 3, so collinearity does not distort the path estimates (Hair et al., 2022).

The model explains a meaningful share of variance in both endogenous constructs. TIC explains 33.6% of the variance in GDC ($R^2 = 0.336$), and TIC and GDC together explain 43.8% of the variance in SP ($R^2 = 0.438$, adjusted $R^2 = 0.429$), which can be described as moderate. PLSpredict returned positive Q^2 predict values for GDC (0.321) and SP (0.274), indicating that the model has predictive relevance beyond a naive benchmark. None of the control variables had a significant effect on SP (firm age $\beta = 0.041$, $p = .412$; firm size $\beta = 0.067$, $p = .168$; manufacturing sector $\beta = 0.032$, $p = .507$).

Direct paths

Table 4 reports the direct effects. TIC had a significant effect on SP ($\beta = 0.430$, $t = 10.277$, $p < .001$), supporting H1. TIC also had a strong effect on GDC ($\beta = 0.252$, $t = 4.418$, $p < .001$), supporting H2. GDC, in turn, had a significant effect on SP ($\beta = 0.374$, $t = 9.109$, $p < .001$), supporting H3. The effect sizes show that TIC is the stronger direct predictor of SP ($f^2 = 0.292$, a medium effect), while the direct effect of TIC on GDC is small ($f^2 = 0.068$). The effect of GDC on SP is medium ($f^2 = 0.202$).

Table 4: Direct Path Model

Path	Beta	SE	TStats	LLCI	ULCI	R Square	F Square
TIC → SP	0.430**	0.042	10.277	0.334	0.500	0.406	0.292

TIC → GDC	0.252**	0.057	4.418	0.130	0.350	0.200	0.068
GDC → SP	0.374**	0.041	9.109	0.294	0.447	0.406	0.220

Note: ** indicate $P < 0.001$; TIC = Technology Innovation Capabilities; SP = Sustainable Performance; GDC = Green Dynamic Capabilities

Mediating path model

Mediation was tested by bootstrapping the indirect effect, which is the recommended approach in PLS-SEM because it makes no assumption about the shape of the indirect effect's sampling distribution (Hair et al., 2022). The indirect effect of TIC on SP through GDC was positive and significant ($\beta = 0.094$, $t = 3.926$, $p < .001$), and its 95% confidence interval [0.048, 0.140] did not include zero. H4 was therefore supported. The total effect of TIC on SP was 0.524 ($t = 13.025$, $p < .001$), made up of the direct effect (0.430) and the indirect effect (0.094). Because both the direct and indirect effects are significant and point in the same direction, the mediation is complementary (partial).

Table 5: Mediating Analysis

Effect	Path	Beta	SE	TStats	LLCI	ULCI
Indirect (H4)	TIC → GDC → SP	0.094**	0.024	3.926	0.048	0.140
Direct	TIC → SP	0.430**	0.042	10.277	0.334	0.500
Total	TIC → SP	0.524**	0.040	13.025	0.438	0.591

Note: ** indicate $P < 0.001$; TIC = Technology Innovation Capabilities; SP = Sustainable Performance; GDC = Green Dynamic Capabilities

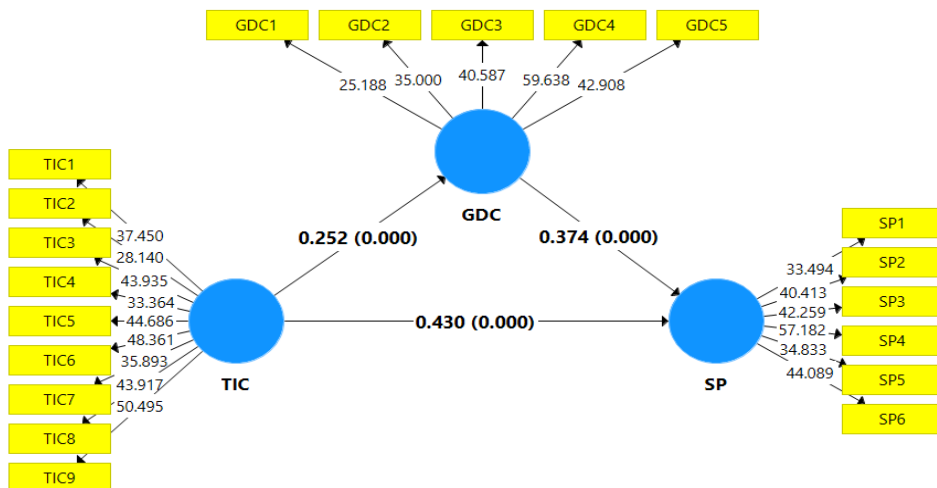


Figure 3: Structural Model; Source: Author

Discussion

The findings highlight that TIC is positively related to SP of SMEs, both directly and indirectly via GDCs. The mediation results show that the overall effect of TIC on SP is mediated by GDCs, implying that the impact of TIC is not fully explained by technological capability alone. On the contrary, the sustainability value of technology seems to rely, in part, on the capacity of the firm to develop and reorganize resources to suit the environmental needs. This result is in line with Alraja et al. (2022) who pointed out that technology is an important enabler for SP and that its usefulness is heightened when firms use it alongside green practices. It also confirms the results of Mady et al. (2023), who showed that the environmental capabilities of manufacturing SMEs do not function independently but are linked to competitive outcomes via eco-innovation.

The correlation between TIC and GDCs is also high ($\beta = 0.252$), offering more insight into the interaction between these capabilities. The finding implies that technological and green capabilities can emerge from related organizational learning processes. SMEs that routinely search for new technology, make use of existing technological resources and learn from external sources are more likely to be able to transfer the same practices to environmental issues. Technological capability has the potential to be an important foundation for developing green-oriented capabilities in this respect. This interpretation is consistent with the absorptive capacity approach of Shahzad et al. (2020) that has a strong focus on the absorptive capacity of firms related to their capacity to recognize, assimilate and utilize external knowledge. It is also in line with the findings of Pakistani high-tech SMEs that dynamic capabilities are also contributing to better environmental outcomes (Niamat & Qureshi, 2025). This relationship is supported by the concept of absorptive capacity. It is found that firms with more technological knowledge are better equipped to identify, incorporate and utilize third-party knowledge, encompassing knowledge on environmental technologies and environmental regulations (Shahzad et al., 2020). GDC are also closely linked with the capacity of the firms to create green products and engage in green innovation, as shown by Qiu et al. (2020). This process will probably continue to rely on some extent on the technological expertise and capacities currently accessible to the company. Additionally, evidence from Pakistani SMEs indicates that firms with higher capability bases have a superior ability to engage in eco-innovation even under resource constraints (Niamat & Qureshi, 2025).

The GDCs are even more important as a direct predictor of SP, indicating the value of organizational adaptation. While TIC offers firms technological resources and knowledge, GDCs help firms coordinate the resources and knowledge with environmental goals. The result is consistent with the past studies that correlate GDC with competitive advantage (Qiu et al., 2020) and green innovation (Yousaf, 2021). Combined, the results suggest that SP is more than the availability of technological resources. Instead, it is a matter of the ability of SMEs to mobilize, adapt and reconfigure those resources to meet environmental and market needs.

Implications

This study adds to the literature by combining the resource-based view (RBV) and Dynamic Capability Theory in a single model. The results indicate that a TIC is a useful organizational capability and that the value of TIC in an organization's sustainability is enhanced when it is supported by a domain-specific dynamic capability, namely GDCs. Within this paradigm, GDCs act as a conversion process that can "convert" technological resources and knowledge into sustainable practices and results. This perspective helps explain why firms with comparable levels of technological capability may achieve different levels of SP. The results, therefore, add to the RBV, by demonstrating that the value of technological resources is derived not just from having them, but from the firm's ability to constantly reconfiguration them in the face of change in the environment.

The results show that, for SME owners and managers, investments in technology need to be accompanied by conscious efforts to build green oriented organizational capabilities. To enhance these capabilities, companies can conduct periodic energy audits, educate staff about cleaner production techniques, and engage suppliers, customers, and other stakeholders with relevant environmental expertise. SMEs can also create basic organizational procedures to track environmental laws and evolving customer needs. Relatively low-cost projects, such as delegating responsibility for tracking environmental trends, can bolster the firm's ability to recognize and act on new green opportunities.

The findings also have implications for organizations that support the growth of SMEs in Pakistan. Support programmes could be targeted to SMMEs by institutions like the Small and Medium Enterprises Development Authority (SMEDA), the Khyber Pakhtunkhwa Board of Investment and Trade, and local chambers of commerce which should combine technological upgrading with environmental capability development. These types of programmes could include, besides financing equipment and/or technologies, cleaner-production advisory services, training in green management practices and technical assistance for environmental innovations. Providing training programmes in clusters within industrial estates also could help SMEs share technological and environmental knowledge, with green financing schemes incentives could be offered to firms that integrate technology adoption with measurable capability development and sustainability targets.

Conclusion and Future Research

This study investigated the effect of SMEs' innovation capability on SP through the intermediation of GDC in KP Province. The findings indicate that TIC contributes to SP through both direct and indirect pathways, with GDCs accounting for a substantial proportion of the overall relationship. The findings indicate that technological capability is a key underlying factor for sustainability, and that GDC help SMEs to convert technological resources into environmentally and economically beneficial results.

There are a number of limitations that offer avenues for further investigation. The first limitation of the cross-sectional and single-respondent design is that it does not allow causal inference. Future

studies might use longitudinal designs or multiple respondents in the individual firms to develop more definitive evidence of temporal and organizational effects. Second, the SP was measured primarily using perceptual indicators. These could be complemented by objective measures in future research, like energy use, waste minimization, emissions, productivity and audited financial performance. Third, future studies might investigate boundary conditions that might reinforce or weaken the proposed relationships. Factors like digital transformation, technological turbulence, environment and regulation, and access to finance could affect the capacity of SMEs to translate technology capabilities into sustainable results. Finally, comparative and multi-group studies may be conducted to check if the suggested mechanism exists differently in manufacturing sector, various sizes of firms and different regions of Pakistan and other emerging economies. The research would have a better understanding of how SMEs can build and manage ability for sustainable technological innovation.

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