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Dynamic Capabilities, Innovation, and Sustainable Competitive Advantage under Environmental Uncertainty in Textile Industry

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Abstract

This study examined the relationship between dynamic capabilities and sustainable competitive advantage through technological and non-technological innovation under environmental uncertainty. The proposed interactive model has been explained using the dynamic capabilities theory. Data were collected from 246 managers in the textile manufacturing industries in Pakistan through a two-point survey. The measurement model showed excellent psychometric qualities for all variable measures. Findings provide that dynamic capabilities have a significant positive relationship with sustainable competitive advantage mediated by technological and non-technological innovations in parallel and serial ways. Environmental uncertainty accelerated the positive impact of dynamic capabilities on both these forms of innovation, leading to sustainable competitive advantage. Findings emphasize the importance of dynamic capabilities in the manufacturing industry and support investment in developing such capabilities, which enhance industry innovation and competitiveness.

Introduction

Firms try to beat competitors through strategic and technological choices. In volatile, uncertain, complex, and ambiguous situations, employing novel and creative ways help firms stay competitive (Troise et al., 2022). The uncertainty involves an unclear situation with multiple operating variables and unstable or unpredictable conditions. The firms must learn to manage uncertainty resulting from external factors like economic conditions, societal trends, or technological advancements. Dynamic managers can continuously monitor their competitors, industry trends, technological

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advances, regulations, market dynamics, and economic developments and take action to prepare for the change and face reality (Pundziene et al., 2022; Teece et al., 1997).

Textile industry in Pakistan is vibrant, active, and export-focused. It generates the nation's most export revenues, around 8.5% of its gross domestic product. But, it is rapidly sliding down, losing market share and credibility with foreign clients for not meeting deadlines and quality expectations (Haq, 2023). Internationalization and the Covid-19 global crisis have also compelled firms to prepare for environmental risks. Sustainable and responsible innovativeness can support a firm's survival and ability to compete (Ivanova, 2021; Severo et al., 2020). Therefore, firms need dynamic capabilities for responsible implementation of technological and non-technological innovations that could support their business competitiveness (Mariam et al., 2022).

However, a gap-spotting appraisal of literature indicated that mechanisms and conditions which explain how dynamic capabilities influence sustainable competitive advantage are understudied in large-scale manufacturing industries, including the textile industry. The critical research question was: how do textile firms in Pakistan use their dynamic capabilities to sustain a competitive advantage under environmental uncertainty? The objective was to empirically answer this question by testing whether dynamic capabilities are related to sustainable competitive advantage, whether technological and non-technological innovation mediate this relationship, and whether environmental uncertainty moderates these relationships. Our findings contribute to dynamic capabilities theory (Teece et al., 1997) by revealing how and when firms use dynamic capabilities to overtake uncertain competitive environments.

Literature Review

Dynamic capability is a firm’s ability to integrate, develop, and rearrange its internal and external resources and competencies to benefit from changing conditions (Teece et al., 1997). Dynamic capabilities offer short-term and long-term competitive advantages (Li & Liu, 2014). Innovation is the application of new ideas for product, process, organization, and marketing (Oecd, 2005). Dynamic capabilities theory assumes that capacities of sensing (evaluating opportunities outside a firm), seizing (timely decision-making to mobilize resources), and transforming (implementing changes required to innovate) allow firms to benefit from their innovativeness more than their competitors (Chirumalla et al., 2023). Managers need dynamic capabilities to adjust their resource base (Grant, 1996) and innovate to achieve their strategic goals (Mukhsin & Suryanto, 2022). Therefore, we argued that a firm with dynamic capabilities might effectively assess the need for change, such as innovation, make wise rapid judgments, and implement the change (Li & Liu, 2014).

Dynamic Capabilities Tie with Sustainable Competitive Advantage

Theory of dynamic capabilities undertakes that organizational capacities of sensing, seizing, and transforming provide firms an advantage over their competitors in

benefiting more from opportunities and innovativeness (Chirumalla et al., 2023). Dynamic capabilities have a nexus with a firm's competitive performance (Michaelis et al., 2021) through innovation (Mukhsin & Suryanto, 2022; Pundziene et al., 2022). Firms possess little or no control over uncertainties and cannot manage continually changing factors through traditional methods. They can benefit in a competitive market if they can accurately sense the environment, promptly make appropriate adjustments, and dynamically implement their change strategies (Li & Liu, 2014; Odwaro et al., 2022). Accordingly, we assumed that firms with dynamic capabilities might acquire a sustainable competitive advantage. Therefore, we proposed that:

Hypothesis 1: Dynamic capabilities are positively associated with a firm's sustainable competitive advantage.

Mediating Role of Technological Innovation

Dynamic capabilities theory emphasizes how innovation gives businesses an advantage over their rivals (Chirumalla et al., 2023). Innovation links dynamic capabilities and competitive performance (Mukhsin & Suryanto, 2022; Pundziene et al., 2022). Firms need dynamic capabilities to sense what innovations may be desired, make wise decisions during the change process, and implement the changes (Li & Liu, 2014; Odwaro et al., 2022). Technological innovation addresses product and process improvement. Product innovations are employed to develop and market new products, while process innovation modifies business processes, inputs, tasks, characteristics, workflow, and information (Zand & Rezaei, 2020). Dynamic capabilities encourage and support implementing technological innovations that deliver value to the stakeholders and add to firm's competitive advantage (Cyfert et al., 2021) and business performance (Zand & Rezaei, 2020). From this perspective, we predicted that:

Hypothesis 2: Technological innovation mediates the association between a firm's dynamic capabilities and sustainable competitive advantage.

Mediating Role of Non-Technological Innovation

Dynamic capabilities benefit firms more from innovation than their competitors (Chirumalla et al., 2023). Organizational and marketing strategies are effective when non-technological innovation is used (Lopez et al., 2022), which helps modernize business practices and prioritize cutting-edge technologies essential for success (Medase & Barasa, 2019). It entails quickly adjusting organizational capabilities and resources per existing market requirements (Grant, 1996). The secret to a firm's creative potential is its capacity to acquire new knowledge from the outside world and enhance internal processes. Thus, success depends on dynamic capabilities that identify the need for change, make informed decisions, and effectively implement the change (Li & Liu, 2014; Odwaro et al., 2022). Firms need to actively leverage innovations in products, price, promotion, and brand positioning to optimize their competitive advantage and reduce the impact of uncertainty (Na et al., 2019). Accordingly, we anticipated that: -

Hypothesis 3: Non-technological innovation mediates the association between a firm's dynamic capabilities and its sustainable competitive advantage.

Serial Mediation of Technological Non-Technological Innovations

Dynamic capabilities theory suggests that firms should implement innovations that deliver a competitive edge (Chirumalla et al., 2023). Innovation performance results from a blend of technological and non-technological innovations (Yoon & Kwon, 2023). Simultaneously employing these innovations can enhance productivity (González-Blanco et al., 2019), performance, and competitive advantage (Yoon & Kwon, 2023). Prior research supports that non-technological change mediates the relationship between technological changes and productivity (Črešnar et al., 2023). Accordingly, technological innovation in a firm would also inspire non-technological innovations to gain competitive outcomes. Hence, we postulated that: -

Hypothesis 4: Technological and non-technological innovations function as serial mediators between the association of a firm's dynamic capabilities and sustainable competitive advantage.

Moderating Effect of Environmental Uncertainty

Environmental uncertainty promotes technological innovation (Chen et al., 2022) as innovativeness expands performance (Arici & Gok, 2023). In dynamic settings, firms try to be innovative (Zand & Rezaei, 2020), as uncertainty persuades learning to improve performance and competitiveness (Fernandes et al., 2017). Organizations respond to uncertainty by adopting technologies, like Industry 4.0, to stay competitive and improve performance (Kumar & Bhatia, 2021). Therefore, managers must use dynamic capabilities to devise innovation strategies that enhance the firm's bottom line and competitive edge (García-Villaverde et al., 2020). Taking into account that environmental uncertainty moderates the relationship between dynamic capability and innovation (Mikalef et al., 2019; Nabi et al., 2023) and that technological innovation mediates dynamic capabilities' relationship with sustainable competitive advantage (hypothesis 2), we proposed that:

Hypothesis 5: Environmental uncertainty (a) elevates the relationship between dynamic capabilities and technological innovation and thereby (b) enhances sustainable competitive advantage.

The influence of dynamic capabilities on innovation improves with increasing environmental uncertainty (Mikalef et al., 2019; Nabi et al., 2023). Non-technological innovation increases the effectiveness of organizational and marketing strategies (Lopez et al., 2022). To upturn their competitiveness and lessen the negative effects of uncertainty, businesses must actively take advantage of developments in products, pricing, promotions, and brand positioning (Na et al., 2019). Taking into account the moderating effect of environmental uncertainty on the relationship between dynamic capability and innovation (Mikalef et al., 2019; Nabi et al., 2023) as well as the

mediating role of non-technological innovation between dynamic capabilities and sustainable competitive advantage (hypothesis 3), we predicted that:

Hypothesis 6: Environmental uncertainty (a) elevates the relationship between dynamic capabilities and non-technological innovation and thereby (b) enhances sustainable competitive advantage.

Environmental uncertainty amplifies dynamic capabilities' beneficial effect on innovation (Mikalef et al., 2019; Nabi et al., 2023). The competitiveness of a firm in technology, growth, and competitive advantage (García-Villaverde et al., 2020) is positively impacted by technological and non-technological innovation activities (Yoon & Kwon, 2023). Taking into account the moderating influence of environmental uncertainty on the dynamic capability and innovation relationship as well as the research indicating sequential mediation of technological and non-technological innovation (hypothesis 4), we anticipated that:

Hypothesis 7: Environmental uncertainty augments the indirect relationship between dynamic capabilities and sustainable competitive advantage via the sequential mediation of technological and non-technological innovations.

Data and Methodology

Context, Procedure, and Sample

Pakistan's textile sector manufacturing firms face intense competition in dynamic local and international marketplaces. In this study, 246 managers of textile manufacturing enterprises participated in a two-wave field survey with a time lag of fifteen days. The potential participants were identified using the members' lists of All-Pakistan Textile Mills Association (APTMA) and All-Pakistan Textile Processing Mills Association (APTPMA) and invited through authors' extended professional network. At time 1, 295 respondents completed an online survey containing questionnaires on participant profiles, dynamic capabilities, and environmental uncertainty. At time-2 (fifteen days after time 1), the respondents of time-1 were requested to retake the questionnaires on technological innovation, non-technological innovation, and sustainable competitive advantage. The survey was completed fifteen days after time-2, with a final sample of 246 young, educated, and experienced textile managers across Pakistan: male (69%) and female (31%) managers holding first-level (44%), middle-level (35%), and senior-level (21%) jobs.

Measures

The study variables were assessed using existing measures on a 5-point scale (1=strongly disagree to 5=strongly agree). A group of six management experts (three from academia and three from industry) with significant research and professional experience evaluated the measures' face and content validity(Alfuqaha et al., 2022).

Items were slightly adjusted per expert recommendations to fit respondents' local context and understanding.

Dynamic capabilities. Firm-level dynamic capabilities (independent variable) of sense making, timely decision making, and change implementation capacities were assessed using fifteen items (Li & Liu, 2014), five items each. "We can perceive environmental change before competitors" is one example item. The scale showed good reliability and validity (α=0.945, CR=0.951).

Environmental uncertainty. Four items evaluated the firms' environmental uncertainty (moderating variable); three items assessed competitors' actions, market conditions, and technological changes (Wang et al., 2022), and one item evaluated the changes in government policies (Boadu et al., 2022). The items included statements like "Competition direction is ever changing in our market". The scale demonstrated good reliability and validity (α=0.754, CR=0.843).

Technological innovation. Eight items evaluated the technological innovation (mediating variable 1) in a firm's products and processes. Product innovation used three items from Saleem et al. (2020) and one item from Severo et al. (2020), such as "The quality of our products is high". Four items evaluated process innovation (Saleem et al., 2020), such as "Technological competitiveness of our processes is high". The scale showed good reliability and validity (α=0.926, CR=0.944).

Non-Technological innovation. Non-technological innovation (mediating variable 2) in organizational and marketing systems was assessed using eight items (Lopez et al., 2022). Four items measured organizational innovation like "New workplace-organization methods for better decision making". Four items assessed marketing innovation, such as "New methods for positioning the product in the market". The scale showed good reliability and validity (α=0.934, CR=0.944).

Sustainable competitive advantage. The six items (Yang et al., 2021), such as "My firm's corporate image is better than its competitors" were used to evaluate a firm's sustainable competitive advantage (dependent variable). The current study's scale showed good validity and reliability (α=0.931, CR=0.946).

Data Analysis and Findings

Correlational Analysis

Table 2 shows significant ($p<0.01$) positive correlations among study variables. Dynamic capabilities are associated with technological innovation (r=0.377), non-technological innovation (r=0.360), and sustainable competitive advantage (r=0.288). Likewise, environmental uncertainty is related to technological innovation (r=0.291), non-technological innovation (r=0.180), and sustainable competitive advantage (r=0.159). Technological and non-technological innovations are also mutually correlated

(r=0.466) and linked to sustainable competitive advantage (r=0.410 and r=0.532, respectively). Therefore, hypothetical relationships were likely to exist.

Measurement Model Assessment

The steps taken to prevent a common method bias included: informed consent, volunteer participation, clarity of instructions, and confidentially (Podsakoff et al., 2012). This issue was not suspected as Harman's one-factor test explained a variation of 28% < 50% (Podsakoff & Organ, 1986). The confirmatory composite analysis, using SmartPLS software, showed a good model fit (Huang et al., 2022): SMSR = 0.055, d_ULS = 2.812, d_G = 1.613, Chi-square = 1999.186, NFI = 0.759. Table 1 shows that VIF values indicated no multicollinearity and all factor loadings were over 0.700 (Fornell & Larcker, 1981). The CRs and CAs values exceeded 0.700, and CR values were greater than AVE for each measure establishing convergent validity (Alfuqaha et al., 2022; Hair et al., 2020). Inter-construct correlations for all variables were lower than their respective square-rooted AVE (Alfuqaha et al., 2022), and HTMT values were less than 0.85 (Henseler et al., 2015), showing discriminant validity. Thus, the measurement model showed adequate validity and reliability.

Structural Model Assessment

Using Bootstrapped PLS structural equation modeling (SEM) based path analysis, Figure 1 and Table 3 displays the outcomes of hypothetical linkages. The proposed hypotheses were tested by looking at the direct, indirect, and total impacts.

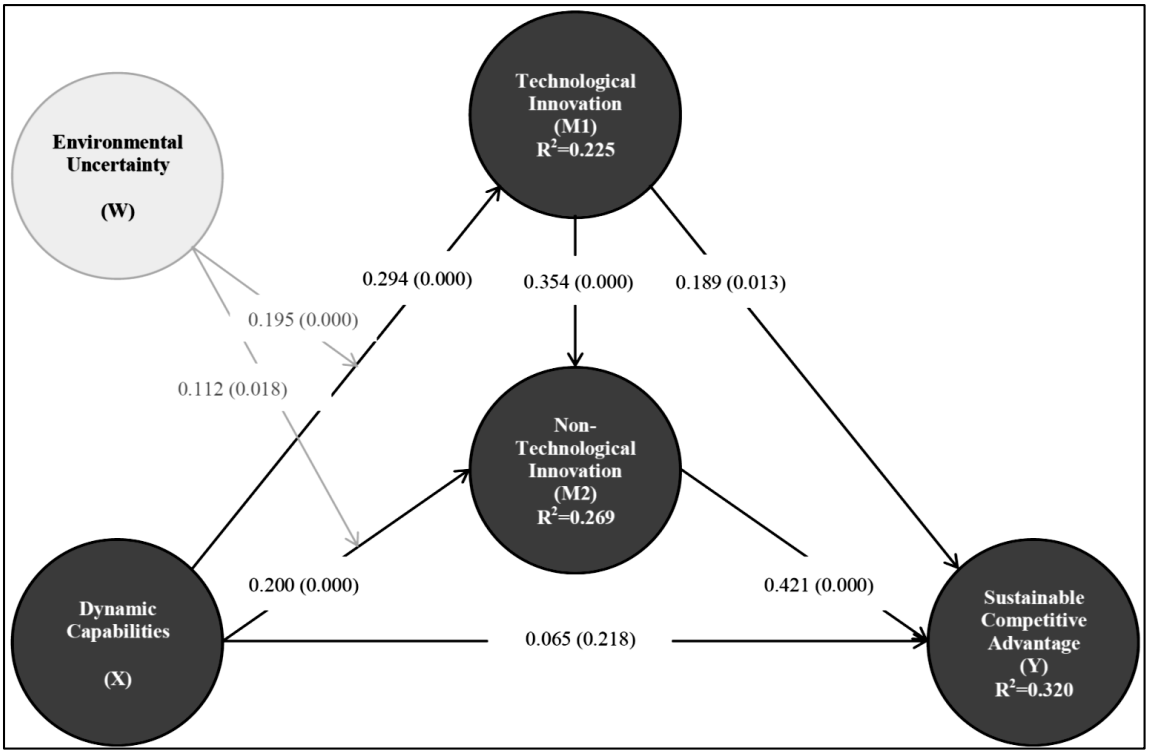

Figure 1: *Structural Path Model*

Table 1: Measurement Model Assessment

Factor Names and Items		AVE	CR	CA	FL	VIF
Environmental Uncertainty (EU)		0.574	0.843	0.754		
1.	EU1				0.780	1.619
2.	EU2				0.811	1.496
3.	EU3				0.730	1.384
4.	EU4				0.706	1.420
Dynamic Capabilities (DC)		0.563	0.951	0.945		
5.	SMC1 (Sense-Making Capacity)				0.777	2.886
6.	SMC2				0.716	3.187
7.	SMC3				0.765	3.141
8.	SMC4				0.816	2.875
9.	SMC5				0.754	2.885
10.	TDC1 (Timely Decision-Making Capacity)				0.723	2.788
11.	TDC2				0.744	2.926
12.	TDC3				0.762	2.586
13.	TDC4				0.724	3.280
14.	TDC5				0.721	2.535
15.	CIC1 (Change Implementation Capacity)				0.723	2.488
16.	CIC2				0.780	3.550
17.	CIC3				0.745	3.280
18.	CIC4				0.737	2.888
19.	CIC5				0.764	3.189
Technological Innovation (TI)		0.660	0.944	0.926		
20.	PDI1 (Product Innovation)				0.819	2.593
21.	PDI2				0.813	2.435
22.	PDI3				0.784	2.300
23.	PDI4				0.824	2.755
24.	PRI1 (Process Innovation)				0.844	2.651
25.	PRI2				0.781	2.116
26.	PRI3				0.806	2.613
27.	PRI4				0.828	3.191
Non-Technological Innovation (NTI)		0.626	0.944	0.934		
28.	MI1 (Marketing Innovation)				0.782	2.396
29.	MI2				0.790	2.581
30.	MI3				0.799	2.347
31.	MI4				0.803	2.536
32.	OI1 (Organizational Innovation)				0.764	2.379
33.	OI2				0.815	2.534
34.	OI3				0.810	2.990
35.	OI4				0.764	2.237
Sustainable Competitive Advantage (SCA)		0.746	0.946	0.931		
36.	SCA1				0.906	3.834
37.	SCA2				0.908	4.421
38.	SCA3				0.803	2.723
39.	SCA4				0.862	3.224
40.	SCA5				0.806	2.150
41.	SCA6				0.890	3.248

Note: AVE=Average variance extracted, CA=Cronbach's Alpha, CR=Composite reliability, FL=Factor loadings, VIF=Variance inflation factor.

Table 2: Correlations and Discriminant Validity

Variables	1	2	3	4	5
1. Environmental Uncertainty	**0.758**	0.264	0.344	0.209	0.190
2. Dynamic Capabilities	0.229**	**0.751**	0.401	0.379	0.304
3. Technological Innovation	0.291**	0.377**	**0.813**	0.499	0.436
4. Non-Technological Innovation	0.180**	0.360**	0.466**	**0.791**	0.565
5. Sustainable Competitive Advantage	0.159**	0.288**	0.410**	0.532**	**0.864**

**p<0.01, Bold values in the diagonal are √AVE, lower diagonal is the correlations matrix, and upper diagonal is the matrix of HTMT values.

Table 3: Path Analysis

Hypotheses	Path	Effect	t	p*	Outcome
H1	DC → SCA (Total)	0.249	4.808	0.000	Supported
H1	DC → SCA (Total indirect)	0.184	5.778	0.000	Supported
H2	DC → TI → SCA	0.056	2.166	0.030	Supported
H3	DC → NTI → SCA	0.084	3.056	0.002	Supported
H4	DC → TI → NTI → SCA	0.044	3.060	0.002	Supported
H5a	DC×EU → TI	0.195	3.829	0.000	Supported
H5b	DC×EU → TI → SCA	0.037	1.970	0.049	Supported
H6a	DC×EU → NTI	0.112	2.362	0.018	Supported
H6b	DC×EU → NTI → SCA	0.047	2.082	0.037	Supported
H7	DC×EU → TI → NTI → SCA	0.029	2.940	0.003	Supported

Note: * significance level p<0.05, DC=Dynamic Capabilities, EU=Environmental Uncertainty, H=Hypothesis, NTI=Non-Technological Innovation, SCA=Sustainable Competitive Advantage, TI=Technological Innovation.

Dynamic capabilities and sustainable competitive advantage. The *first* hypothesis examined dynamic capabilities in relation to sustainable competitive advantage. A significant (p<0.01) positive correlation (0.288), total effect (0.249), and total indirect effect (0.184) between both these variables supported H1.

The mediating role of technological innovation. The *second* hypothesis examined that the linkage between dynamic capabilities and sustainable competitive advantage is mediated through technological innovation. Results significantly (p<0.01) supported that dynamic capabilities are positively correlated with technological innovation (0.377), which is positively correlated with sustainable competitive advantage (0.410). Path analysis revealed a significant (p<0.01) positive indirect effect between dynamic capabilities and sustainable competitive advantage through technological innovation (0.056). Hence, H2 was accepted.

The mediating role of non-technological innovation. The *third* hypothesis pronounced that the linkage of dynamic capabilities and sustainable competitive advantage is mediated through non-technological innovation. Results significantly (p<0.01) showed that dynamic capabilities are positively correlated with non-technological innovation (0.360), which has a positive association with sustainable competitive advantage (0.532). Path analysis showed a significant (p<0.01) positive indirect effect (0.084)

between dynamic capabilities and sustainable competitive advantage via non-technological innovation. These results confirmed H3.

Serial mediation process. The *fourth* hypothesis evaluated the sequential mediation between dynamic capabilities and sustainable competitive advantage. Through this sequential mediation process, the path analysis revealed a significant ($p<0.01$) indirect positive effect of dynamic capabilities on sustainable competitive advantage (0.044). These findings endorsed H4.

Moderating effect of environmental uncertainty. The *fifth* hypothesis examined moderating effect of environmental uncertainty on technological innovation and sustainable competitive advantage. Environmental uncertainty showed significant ($p<0.01$) positive correlations with technological innovation (0.291) and sustainable competitive advantage (0.159). The interaction term (dynamic capabilities × environmental uncertainty) showed a significant ($p<0.01$) positive effect on technological innovation (0.195) and, thereby, an indirect positive impact on sustainable competitive advantage (0.037). Hence, H5a and H5b are accepted.

The *sixth* hypothesis tested moderating effect of environmental uncertainty on non-technological innovations and sustainable competitive advantage. Environmental uncertainty showed significant ($p<0.01$) positive correlations with non-technological innovation (0.180) and sustainable competitive advantage (0.159). The interaction term (dynamic capabilities × environmental uncertainty) showed a significant ($p<0.01$) positive effect on non-technological innovation (0.112) and, thereby, an indirect positive effect on sustainable competitive advantage (0.047). These results supported H6a and H6b.

Finally, the *seventh* hypothesis tested the indirect moderating effect of environmental uncertainty on sustainable competitive advantage via sequential mediation of technological and non-technological innovation. The interaction term (dynamic capabilities × environmental uncertainty) showed a significant ($p<0.01$) positive indirect effect on sustainable competitive advantage through the proposed sequential mediation process (0.029). This supported H7.

Discussion

In the light of dynamic capability theory, this study confirmed that dynamic capabilities are positively linked with a firm's sustainable competitive advantage through innovation. Technological and non-technological innovations mediated this relationship in both parallel and serial ways. This mediated relationship was stronger under high environmental uncertainty, which enhanced sustainable competitive advantage by moderating (escalating) the linkage of dynamic capabilities with technological and non-technology innovations. Implications of these outcomes for theory and practice are discussed as follows.

Theoretical Implications

Dynamic capabilities view suggests implementing innovations that provide a competitive edge over competitors (Chirumalla et al., 2023). However, not every firm invests heavily in innovations due to resource limitations, environmental uncertainties, and likely unsuccessful outcomes. Our findings offer empirical support to the dynamic capability theory by demonstrating that technological and non-technological innovations can retain competitive advantage for firms despite environmental uncertainty. The outcomes are consistent with the prior research, signifying that dynamic capabilities facilitate firms in gaining sustained competitive advantage (Michaelis et al., 2021) through innovation (Pundziene et al., 2022). The findings also support that the changes in technological factors persuade changes in non-technological factors to create an effective alignment to fetch desired productivity (Črešnar et al., 2023). Environmental uncertainty motivates firms to introduce innovations that effectively respond to external factors (Zand & Rezaei, 2020), improve performance (Arici & Gok, 2023), and sustain competitiveness (Fernandes et al., 2017).

Practical Implications

Intense competition requires firms to plan and implement effective strategies, such as industry 4.0 and 5.0 innovations, to respond to unpredictable external factors, stay competitive, and improve performance (Kumar & Bhatia, 2021). Findings support that dynamic capabilities are the source of sustained competitive advantage as they enable firms to sense the frequently occurring changes in the external environment, facilitate decision making, and support how to implement desired changes effectively (Li & Liu, 2014). Thus, the dynamic capabilities should be developed and strengthened to renew firm resources and implement technological and non-technological innovations that support long-term competitive advantage in a dynamic industry environment. It may lead the firm performance to desired levels.

Limitations and Future Research

This study examined the proposed model in the Pakistani textile industry. More research with a larger and diversified sample would exhibit the effectiveness of findings across a wide range of manufacturing industries. Data was gathered in two waves. Future studies may consider longitudinal or three-wave approaches to prevent response biases. Data was collected on firm age and size (number of employees) as control variables but not included in the analysis due to the large number of missing values. Considerable investments in innovation necessitate a steady or predictable economic environment. Pakistan is experiencing intense political turmoil, economic uncertainty, and security issues, which could affect how industries view investments in leading-edge technologies. These factors may be studied as moderating or control variables in future research. Further investigation is also required to determine the extent to which large manufacturing firms engage in responsible innovation practices (Mariam et al., 2022)

and their predictive role in implementing technological innovations to pursue competitive advantage and improve firm performance.

Conclusion

The measures used in this study indicated acceptable validity and reliability for use in the large-scale manufacturing industry. Results supported the proposed moderated-mediated model. Dynamic capabilities facilitate the adoption of technological and non-technological innovations, which, in serial and parallel ways, promote a sustainable competitive advantage. The environmental uncertainty further leveraged the benefits of dynamic capabilities to scale up every innovation stage for a sustainable competitive advantage.

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