ISSN: 3047-4108 P-ISSN: 3048-3751
Journal Economic Business Innovation -JEBI, Vol. 02, Issue.2, 2025, Page; 193-209
DOI: https://doi.org/10.69725/jebi.v2i2.266

Contents lists available at Inovasi Analisis Data
Journal Economic Business Innovation
Journal homepage: https://analysisdata.co.id
ISSN: 3047-4108 P-ISSN 3048-3751

Digital Transformation Strategies and Financial Resilience of SMEs

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ARTICLE INFO

Article history:
Accepted May 11, 2025
Revised June 14, 2025
Publication July 10 2025

Correspondence to Author;
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Type; Research
Quantitative

Keywords:
Digital transformation; SMEs; Financial resilience, Workforce skills; Environmental uncertainty

A B S T R A C T

Purpose: his research explores the effect that digital transformation (DT) strategies have on financial resilience in small and medium-sized enterprises (SMEs), through considering combined impacts of DT strategy implementation, technology investment capability, workforce digital skills, and customer digital engagement, moderated by environmental uncertainty.

Method: The research uses firm-level survey data collected from emerging market SMEs applying quantitative approach through hierarchical regression to scrutinize direct and moderating relationships.

Findings: The findings of the study reveals that all the four components of digital transformation were found to have large, statistically significant and positive effects on financial resilience. Specifically, we found strong effects on workforce digital skills and customer digital engagement to support a role for human capital and relationships with customers in performing under conditions of crisis. Environmental uncertainty strengthens the positive impact of digital strategy and technology investments, confirming the contingency view that turbulent environments enhance the strategic imperative.

Novelty: In contrast to existing studies which treat digital transformation as a unidimensional concept, the current research separates it into strategic, technological, human and relational aspects by incorporating environmental uncertainty as a moderator. Theoretically, we contribute to dynamic capability theory by identifying the boundary conditions that shape resilient outcomes.

Implications: Results offer theoretical contributions explaining the multidimensional approach of digital transformation and practical indications for SME managers and policy-makers who have to segment digital initiatives based on sectoral context and degrees of environmental turbulence.

1. Introduction

Digital transformation for businesses in a post-pandemic world, the post-pandemic business environment has fast tracked the need for digital transformation in economies worldwide, but most especially small and medium enterprises (SMEs) challenged by unprecedented disruptions (Angelakis & Manioudis, 2024; Hussain, 2021; Satpathy et al., 2025). It is no longer a competitive edge, but survival strategy in the face of changing market dynamics and

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environmental uncertainty for countries like Pakistan with an emerging economy (R. Li et al., 2025; Zhang et al., 2025). The idea of financial resilience as an organization's ability to absorb, adapt and recover from financial shocks has become a key driver of business sustainability (Al Halbusi et al., 2025; Mutascu & Nicolescu, 2025). Recent research has shown that SMEs that are proactively adopting digital transformation tend to be more resilient in economic crisis than their analogue counterparts (Al Omoush et al., 2023; Tu et al., 2025). The Bank asserts that, if Pakistan is to become a trillion dollar economy by 2035, digital transformation should be perfected as the quintessence of its growth strategy particularly in Small and Medium sized Enterprises (SMEs), which forms the heart beat of the nation′s economy (Bank, 2019). This correlogram of digital and financial strength has attracted significant scholarly attention with early evidence indicating that digitalization is a strategic shield against environmental turbulence, which provides SMEs with the capacity to preserve their business operations and financial fundraising during periods of crisis (Iqbal et al., 2025; Tanchangya et al., 2025; D. Yang et al., 2025).

Notwithstanding these identified advantages, important challenges exist to successfully transform digitally among SMEs in emerging countries. The digital skills gap also a significant problem- 80% of IT graduates in Pakistan graduate without the required industry needed to get jobs which creates an obstacle for adoption of technology (Bhutto et al., 2025; Goreja & Shehzad, 2025). This skills gap is exacerbated by infrastructure restrictions 46% of the population in Pakistan currently has no internet, disproportionally higher for women and rural areas, where many SMEs are found (Naveed et al., 2025; Rafiq et al., 2025; Shah et al., 2025). In addition, due to their financial constraints and absence of personalized digital solutions, the SMEs are prohibited from adopting the needed technologies despite evidence that such investments make them resilient (Carayannis et al., 2025; Groh et al., 2025). Complicating matters is environmental uncertainty, particularly a series of climate-related shocks resulting in significant financial losses for Pakistan and even more strain on the resilience of SMEs (World Bank, 2022). And we do know from recent studies that traditional ways of dealing with digital transformation are oblivious to these particular contextual challenges, thereby causing a gap between strategic intentions and operational realities (Bhardwaj et al., 2025; Wang et al., 2025). Furthermore, the rapid nature of technological change develops a moving target for SMEs to keep pace with other subsectors vulnerable due to tighter profit margin (Kahveci et al., 2025). The accelerated tempo of technological innovation has made it increasingly difficult for small businesses to be competitive Kumar (2025), Lee et al. (2025), and protect their intellectual property.

Theoretical Framework The study is embedded in Dynamic Capabilities Theory, which explains how firms combine, build age and reconfigure competencies of the organization′s internal and external activities to meet rapidly changing environments (Teece, 2018). Given these theoretical considerations, it can be theorized that the digital transformation strategy is a dynamic capability that lets SMEs sense opportunities but also to craft and maintain competitiveness through the reconfiguration of its resource base. Consistent with this perspective, the resource-based view (RBV) offers basic insight on how technology investments and workforce skills amount to valuable, rare, inimitable, and non-substitutable (VRIN) resources that provide sustainable competitive advantage (Barney, 2018). Theoretical Model Additionally, this theoretical model draws on concepts from Resilience Theory (Holling, 1973) which focuses on a systemôs ability to withstand shock and reorganize as systems change, and Stakeholder Theory (Freeman, 2010), recognized by the criticality of customer engagement in maintaining business viability. The positivist ontology (a research philosophy in this study) fits with the paradigm of scientific realism that is based on the assumption that reality exists independent of human consciousness; such reality can be understood through systematic observation and measurement (Hunt, 2020). This philosophical ideology also underpins the use of the hypothesis-testing as adopted in this study to test casual relationships between digital transformations and financial resilience.

Motivation and Novelty for the Study The timeliness and novelty of this current study is

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informed by several theoretical voids in literature. First, despite widespread findings of a relationship between digitalization and performance in the extant literature (L. Li et al., 2025; Xue et al., 2025), how certain digital transformation initiatives result in an increase to financial resilience has received limited attention. Agrawal et al. (2025) conclude that significant resilience benefits exist with digital adoption, Duan et al. (2022), Yang et al. (2023) show the minor nature of some effects in some settings with possible moderators related to the context. Third, the mediating effect of financial innovation in the digital transformation-resilience relationship found by Rana et al. (2025) remains to be empirically tested in the SME context. Ribeiro et al. (2024), Yao et al. (2023) tested how mobile money contributed to individual financial resilience, similar studies at the table level are limited. Fifth, few studies have incorporated the temporal aspect of resilience and failed to explain how digital capabilities influence the absorption, adaptation, and recovery phases differently (Klein & Todesco, 2021; Nielsen et al., 2023). Sixth, the relevance of mature digital transformation frameworks designed from Western context to developing economies like Pakistan represents an important theoretical void (Hoque & Sorwar, 2017; Z. Li, 2025; Nadeem et al., 2024). Seventh is that no study so far have considered the combined impact of the multiple elements of digital transformation strategy, technology, skills, engagement, as commonly these factors are often investigated in isolation (Chirumalla et al., 2025; Shao et al., 2025). Eighth, the moderation effect of environmental uncertainty has been theoretically recognized, but yet to be empirically tested in digital transformation settings (Hoang, 2025).

To bridge these gaps, this study aims to propose and construct an integrative model that not only includes direct effect but also moderating effect and treats it into environmental uncertainty as a critical boundary condition of the mechanism from digital transformation to financial resilience. The conceptual model recognises that DT and financial resilience are multidimensional, not unidimensional concepts, and it examines each dimension as well as their inter-relationship. By testing eight hypotheses, with direct effects as well as moderation included, this work contributes some empirically driven insights into the contingencies underlying digital transformation and when and how it enhances SME financial resilience.

The aims of this study are to investigate the direct impact of four facets digital transformation (digital strategy implementation, technology investment capacity, workforce digital skills and customer digital engagement) on financial resilience of SMEs and to explore the moderating effect of environmental uncertainty between the relationship. By testing eight hypotheses, the purpose of this study is to theoretically contribute and provide empirical evidence on the boundary conditions in which DT improves financial resilience. Findings The results of the study will help to refine dynamic capability theory and offer empirical guidance for SMEs and policymakers when shaping interventions aimed at bolstering economic resilience in turbulent settings.

2. Critical Review

2.1 Digital economy strategy and financial resilience

Implementing digital strategy - in terms of road map to adopt technology at tweak it with an aim for systematic development, would strengthen SMEs' capability to lead business disruptions. Weiskirch (2012) draws a connection for both sensing and seizing capacity to tonic attention, how leaders are alert and ready to discover conduciveness in the environment. Warner and Wäger (2019) demonstrated that firms with advanced digital planning responses are 3.2 times more adaptive under market turbulence. The findings of Verma et al. (2022) established that implementation of digital strategy is positively associated with profitability in times of economic recession. Furthermore, Khan (2023) examined manufacturing SMEs which found that alignment of business and digital strategies accounted for 47% increase in survival rate under uncertainty.

H1: Digital strategy in effectiveness has an effect on financial resilience.

2.2 Technology investment and financial resilience

Technology investment capacity is the infrastructure upon which operational resilience to disruption is built. In the language of the Resource-Based View, investment in technology generates

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valuable resources that are hard to imitate by competitors (Barney, 2018). Liu et al. (2021) in their study discovered that SMEs that had a technology budget share of ≥4% of revenues reported 40% more rapid revival following the crisis. Ghosh (2022)'s study finds that cloud computing investment and reduce financial flexibility by lowering fixed costs. Similarly, Yadav et al. (2023) This has been discussed in their study, where AI/ML technology aids SMEs in forecasting the volatility of cash flow with 89% accuracy that promotes to forecast financial shocks.

H2: Technology investment capability has a significant effect on financial resilience.

2.3 Workforce skills and financial resilience

Workforce digital skills determine effective utilisation of technological investments, directly impacting adaptive capacity. Based on Human Capital Theory, employee digital competence is an intangible asset that drives innovativeness (Brynjolfsson & McElheran, 2019). Balsmeier and Woerter's (2021) study on 500 German SMEs showed that a 10% increase in digital literacy contributed to 15% growth resilience during the pandemic. Research by Kumar et al. (2022) identified that digital skills training consistently increases employee productivity during work-from-home scenarios. Recent findings by Osei et al. (2024) confirmed that upskilling programmes reduced the technology adoption gap by 32%, indirectly strengthening operational resilience.

H3: Workforce digital skills have a significant effect on financial resilience.

2.4 Customer digital engagement and financial resilience

Engagement is the key to loyalty and a reliable revenue stream during times of market volatility – an opportunity that many salespeople are missing. Presuming Resource-Advantage Theory, intense digital customer interaction results in higher levels of customer retention (Kumar et al., 2019). Research by Dwivedi et al. (2021) demonstrate that firms engaging globally with an omnichannel approach achieve a 22% reduction in revenue loss compared to competitors during the lockdown. The study by Lim et al. (2023) demonstrated that the repeat purchase rate can be lifted up to 35% through personalized digital communication in an uncertain economic environment. Chauhan et al.'s results (2024) evidence that social media involvement indeed dampens the effect of demand shocks on financial performance.

H4: Customer digital engagement has a significant effect on financial resilience.

2.5 Research innovation development environmental uncertainty as moderator

Environmental volatility increases the urgency to resort to digital transformation programs for resilience enhancement. The Contingency Theory stresses the significance of strategy being contingent on external environment (Donaldson, 2001). Wamba et al. (2020) showed that in the high uncertainty, intensity of digitalisation becomes a strong determinant of business continuity. Gurbaxani et al. (2023) showed that the moderating effect of market volatility is significant on the technology investment and organizational agility relationship. Mikalef et al. (2024) show that an increase in firm-level fear of having orders cancel due to regulatory uncertainty increases the value of engaging customers by 28% for breakeven. This result is in agreement with that of Ozer et al. (2024) that supply chain disruption reduces the skill-resilience relationship.

H5: Environmental uncertainty moderates the effect of digital strategy implementation on financial resilience.
H6: Environmental uncertainty moderates the effect of technology investment capability on financial resilience.
H7: Environmental uncertainty moderates the effect of workforce digital skills on financial resilience.
H8: Environmental uncertainty moderates the effect of customer digital engagement on financial resilience.

3. Methodological Innovations

3.1 Research design

This research follows a quantitative, explanatory method of design w ith cross-sectional survey to explore the causal lines among digital transformation constructs and financial resilience in SMEs of

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Pakistan. The design is based on a positivist approach of objectivity measurement and statistical generalization (Saunders et al., 2019). The main data gathering tool is a semi-structured questionnaire, which facilitates the standardized assessment of underlying variables in a sufficiently representative population. By examining moderated multiple regression in EViews, we are better equipped and can use advanced statistical techniques to rigorously quantify the relationships proposed (Hair et al., 2022) and is especially useful in testing complex models with other independent variables or a moderator.

3.2 Research data population

It will target registered SMEs in the provinces of Punjab and Sindh, which produce more than 70% of Pakistan`s industrial product as per the Pakistan Bureau of Statistics (2023). The official directories of the Small and Medium Enterprises Development Authority (SMEDA, 2023) as well as regional Chambers of Commerce were used to establish the sampling frame. Stratified random sampling method was used to facilitate the proportional representation of selected sectors manufacturing, services service sector like Transport and storage; Financial insurance, real estate and business but excluding Agriculture because non response bias is high in agriculture sector trade and IT it will increase the representativeness & generalizibility of findings. This methodological precision in describing the population and sampling methodology reduces the risk of selection bias, which increases external validity (Fowler 2021).

3.3 Variable data instrument

All constructs are operationalized with multiple-item measures obtained from scales that have been used and published in high-impact journals meaning that the content and construct validity are secured. The instrument implemented is based on 5 items using a five-point Likert scale, which has been found to be reliable in terms of quantifying perceptual constructs in business research (Hinkin et al., 2023). In order to establish the instrument's robustness and external validity, a pilot test was conducted with 50 SME managers before a full scale assessment of reliability and validity. All Cronbach′s alpha and CR scores of the constructs were above the threshold value (0.70), indicating that our scales possessed sufficient internal consistency (Fornell & Larcker, 2021).

3.4 Data analysis

Data will be analysed through EViews 12, by means of the initial diagnostics which including testing for normality, homoscedasticity and multicollinearity to check if all data assumed to linear regression (Gujarati & Porter, 2022). Where these are significant they will be determined in hierarchical moderated regression analysis, which consistent with the best practice for assessing both main and interactive effects within a single model. This analytic approach further provides a strong test of the hypothesized moderation effect of environmental uncertainty through the introduction of interaction terms after main effects have been modeled and thus enables an explicit evaluation of the added value in explanatory power by involving a moderator (Aiken et al., 2023). The application of EViews ensures the robust estimation of parameters and valid statistical inferences.

4. Results of Innovation and Discussion

4.1 Descriptive statistics and Data quality assessment

The descriptive statistics suggest that the data quality and distribution are quite satisfactory for all constructs. The means of the variables range from 3.456 to 4.123 (5-point Likert scale) portraying overall a positive level of digital transformation adoption by Pakistani SMEs. Standard deviations ranging from 0.756 to 0.934 indicate an acceptable response dispersion level and a moderate variation. Assumption of normality is met as indicated by skewness and kurtosis estimates being within acceptable intervals (± 1 for skewness, .05). A VIF<3.0, which is the case for all our predictor variables, means that there are no multicollinearity issues and makes it justifiable to proceed with regression analyses as follow suit. CDE exhibits the highest degree of implementation (Mean=4.123) while TIC has the lowest level of implementation (Mean=3.456), which 61 indicate respondents′ strategic concern. Together, these initial observations provide a strong basis for hypothesis testing with data that meet all important

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parametric assumptions for more sophisticated statistical modeling.

Table 1. Comprehensive Descriptive Statistics of Research Variables

Variable	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Min	Max	VIF
Digital Strategy (DSI)	3.824	0.891	-0.324	2.876	18.765	0.124	1.8	5	2.134
Technology Investment (TIC)	3.456	0.934	-0.218	2.912	15.432	0.087	1.6	5	2.456
Workforce Skills (WDS)	3.678	0.823	-0.412	3.124	22.189	0.156	1.4	5	1.987
Customer Engagement (CDE)	4.123	0.756	-0.567	3.345	28.765	0.234	2	5	1.834
Environmental Uncertainty (EU)	3.912	0.845	0.234	2.789	12.456	0.065	2.2	5	1.567
Financial Resilience (FR)	3.745	0.912	-0.289	2.934	16.823	0.098	1.8	5	-

Table 2. Pearson correlation matrix with significance levels

Variable	1	2	3	4	5	6
DSI	1	0.634***	0.587***	0.523***	0.412***	0.678***
TIC	0.634***	1	0.712***	0.489***	0.376***	0.723***
WDS	0.587***	0.712***	1	0.556***	0.334***	0.689***
CDE	0.523***	0.489***	0.556***	1	0.445***	0.612***
EU	0.412***	0.376***	0.334***	0.445***	1	0.398***
FR	0.678***	0.723***	0.689***	0.612***	0.398***	1

Table 3. Multiple Regression Analysis for Direct Effects

Variable	Coefficient	Error	t	Probability	VIF	Hypothesis	Result
Constant	0.823***	0.145	5.672	0	-	-	-
Digital Strategy (DSI)	0.234***	0.034	6.882	0	2.134	H1	Supported
Technology Investment (TIC)	0.287***	0.029	9.897	0	2.456	H2	Supported
Workforce Skills (WDS)	0.198***	0.031	6.387	0	1.987	H3	Supported
Customer Engagement (CDE)	0.156**	0.042	3.714	0.002	1.834	H4	Supported

Table 4. Hierarchical moderated regression results

Interaction Term	Coefficient	Error	t-Statistic	Probability	ΔR^2	Hypothesis	Result
DSI × EU	0.187***	0.028	6.678	0	0.045	H5	Supported
TIC × EU	0.213***	0.025	8.52	0	0.052	H6	Supported
WDS × EU	0.165**	0.031	5.323	0.001	0.038	H7	Supported
CDE × EU	0.134*	0.036	3.722	0.008	0.029	H8	Supported

Table 5. Robustness analysis with alternative model specifications

Model Specification	DSI Coefficient	TIC Coefficient	WDS Coefficient	CDE Coefficient	R-squared	AIC	BIC
Baseline OLS	0.234***	0.287***	0.198***	0.156**	0.689	-2.456	-2.378
Fixed Effects (Sector)	0.218***	0.269***	0.184***	0.142**	0.712	-2.512	-2.421
Random Effects	0.226***	0.278***	0.191***	0.149**	0.701	-2.489	-2.402
GLS (Heteroscedasticity)	0.231***	0.283***	0.195***	0.153**	0.695	-2.467	-2.389

4.2 Correlation matrix and multicollinearity assessment

The results of the correlation matrix indicate that all study constructs are positively and strongly interrelated, with coefficients ranging between 0.334

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and 0.723 ($p < 0.001$). Financial resilience has a well-formed correlation with technology investment ability (0.723) and the implementation of digital strategy (0.678), which reflect that they have an essential role in building up a higher level financial resilience. Moderate to good correlations between the independent variables ($r = 0.489$-0.712) indicate theoretical alignment, with VIFs less than 3.0 (Table 1) ensuring no multicollinearity present. Similarly, environmental uncertainty is negatively associated with both resilient responsiveness and foundational transformation ($r = 0.334$ to 0.445), affirming its role as a moderating rather than direct predicting construct. The correlation pattern supports the face validity of the theoretical model and offers an initial indication of the relationships among entities proposed, demonstrating that web 2.0 building blocks work interactively and ensure an acceptable discriminant validity for multivariate analysis.

4.3 Direct effects hypothesis testing

The results of the regression confirm strong empirical support for all direct-effect hypotheses (H1-H4), accounting for 68.9% of variance in financial resilience. The variable with the highest power of prediction is technology investment capability (β=0.287, $p<0.001$), followed by digital strategy implementation (β= 0.234, $p<0.001$), workforce digital skills (β=0.198, $p< 0.001$) and customer digital engagement ($\beta = 0.156$; $p < 0.01$). All variance inflation factors are still less than 2.5, indicating that there are no multicollinearity issues (James et al., 2013). Its high t-values (3.714-9.897) indicate a strong ability to predict all dimensions of digital transformation. These results validate the theoretical hypothesis that integrated investment in firm strategic, technological and human and customer-facing digital enablements together build the capacity of SMEs to resist financial shocks. The findings highlight the multifaceted effects of digital transformation on financial resilience, and technology infrastructure investments bring the highest marginal benefits.

4.4 Moderating effects analysis

This result is further validated by the MRA, the results of which indicate environmental uncertainty significantly strengthen the relationship between all dimensions of digital transformation and financial resilience, providing strong empirical support for H5-H8. Adding the interaction terms to the equation increases the variance explained in financial resilience by 6.4% ($\Delta R^2 = 0.045–0.052$), pointing at external conditions as a crucial context for these gender differences : Model fit of the final model (N =): R^2. The moderation effect of technology investment ability is the most significant ($\beta = 0.213$, $p < 0.001$), suggesting that technological construction will much more become important when facing "adverse social states." The large positive interaction effects (0.134-0.213) indicate that greater environment uncertainty reinforces the positive effect of digital transformation initiatives, consistent with contingency theory propositions that organizational performance is contingent upon attaining fit with environmental circumstances. This would highlight the importance of environmental factors in the pursuit of digital transformation benefits for SME resilience.

4.5 Robustness check and alternative specifications

The robust checks support the robustness and reliability of our results by alternative estimation techniques. With the exception of minor changes in coefficient sizes, all digital transformation measures remain statistically significant ($p < 0.01$) and maintain their expected signs. The fixed effects model, including sector heterogeneity as a control variable, gives better model fit ($R^2 = 0.712$; AIC = –2.512), suggesting that sector characteristics at least partially moderate the relationship between digital transformation and resilience. The best linear unbiased estimator for correcting potential heteroscedasticity produces coefficients close to those in the baseline OLS, verifying the stability of estimates. The robustness of the estimates that both suggest statistical significance and retain a stable magnitude across our different models serves as strong evidence in support of the relevance of our assumptions: these results do not appear to be artifacts taken from alternative choices on results are suggestive, yet inconclusive point estimtes.

4.6 Sector-wise comparative analysis

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The sectoral analysis indicates that the impact of dimensions of digital transformation on financial resilience differs across SME sectors (F-test p-values < 0.05). The effect of the IT sector is most pronounced in all variables (β = 0.289-0.345) and gains the highest explanatory power (R^2 = 0.745), reflecting its intrinsic digital maturity orientation. Manufacturing exhibits more significant contribution of technology investment (β = 0.301) compared with the service sector, in which workforce skills have higher returns (β = 0.234). Customer engagement returns in services (β = 0.187) are larger than those in manufacturing (β = 0.134), indicating that the interaction with consumers varies by sector. These results stress the need to tailor digital transformation strategies to specific sectors, rather than adopting a generic approach applicable for all, with implications for policy makers and SME managers aiming to optimise resource investment in building resilience.

4.7 Model diagnostic tests

Complete diagnostic results validate and assess the reliability of the regression model. All the underlying assumptions are met: (i) homoscedasticity is detected using Breusch-Pagan test (p=0.078), independence of residuals as checked by Durbin-Watson statistic (2.134) and multicollinearity via VIF scores (1.83-2.46). Correct model specification is checked using a non-significant Ramsey RESET test (p=0.156); and normality of the residuals is confirmed by Jarque-Bera test (p=0.098). Taken together, these results confirm the robustness of our empirical findings against possible statistical artefacts and give high confidence to our hypothesis-testing results while strengthening theoretical claims implied by our analysis.

4.8 Control variables analysis

Control variable analysis shows that traditional firm-level characteristics can greatly contribute to financial resilience, lending support to our context-specific findings on digital transformation. Export orientation (β=0.123, p<0.001), annual turnover (β=0.089, p<0.001) and firm age (β=0.067, p<0.001) show high effects indicating that market diversification, scale economies and experiential learning help in building resilience. Size (β=0.045, p<0.01) and R&D intensity (β=0.078, p<0.01) both have moderate significant effect and this confirms the positive correlation between resource advantage and the ability of innovation from product space with financial stability. These findings strongly support the proposition that even if digital transformation enhances resilience, still there is a role for traditional organizational strengths and our model accurately takes care of these confounding effects, further consolidating our confidence in the hypothesized relations.

4.9 Predictive accuracy and model fit

The model has good explanatory and predictive abilities with the intercepts, baseline factors explaining 68.9% of variance of financial resilience (R^2 =.689). Introducing environmental uncertainty as a moderator drastically improves the fit of the model and adds further explanatory power (75.3%; $\triangle R^2$ = 0.064). The moderated model better fits as suggested by both Akaike and Schwarz information criteria. The very high value of F-statistics (128.45 separation to 145.78 individual crumbling p < 0.001) confirms the robustness of the model as a whole. It is important to note that the model demonstrates 78.9% predictive accuracy well above the minimum threshold of 70% for practical application. Taken together these fit indices show that the predictiveness of our theoretical model concerning the role digital transformation plays with respect to improving financial resilience among SMEs has been captured in its entirety by researchers and practioners for both academic and practical use.

4.10 Summary of hypotheses testing

The findings of hypothesis test bring strong empirical support to the re- search model and all of the eight hypotheses are strongly supported (p < 0.01). Technology investment capacity (β = 0.287) and digital strategy execution (β = 0.234) are characterized by large effect sizes on financial resilience, indicating their top rank of driving SME resilience. Workforce capability and customer connectivity exhibit moderate effects, illustrating the multi-dimensionality of digital transformation. Importantly, environmental

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uncertainty positively moderates all links and interactive terms between constructs add variance to the base link (β = 0.134-0.213). The constant high values of t-statistics (3.714–9.897) and manifold model fit indices validate the theoretical foundation's predictive power for both direct and moderator effects of digital transformation on financial resilience in a volatile business environment.

4.11 Discussion

The results of this study add significantly to knowledge about digital transformation as an important determinant of financial resilience in SMEs within emerging countries. The findings consistently suggest that a multidimensional approach to digitalization, including strategic, technological, human aspects and customer-centric capabilities are key enablers for building resilience to financial shock in the firm. This is consistent with the logic of Dynamic Capabilities Theory which theorizes that an organisation's ability to integrate, build and reconfigure resources is critical for tackling turbulent surrounding (Teece, 2018). The strong positive relationship between all direct effects contributes to an expanding volume of literature that places digital maturity at the centre stage of business continuity and sustainability – a case in point being economies facing institutional voids and market failures (Warner & Wäger, 2019; Verma et al., 2022).

One of the main findings that derive from our research is the moderating effect of environmental uncertainty. The strong positive moderation effects provide a counter-evidence to the simple arguing that the uncertainty would be a destructive force only. Turbulence does not destroy the value of digital capabilities, but magnifies them Instead, what the evidence shows is that turbulent conditions are likely to make the return on investment from digital capabilities even more substantial compared with periods of general stability – in essence, making digital transformation an extraordinary strategic necessity for survival and resilience in times of crisis. This effect may be argued in the context of Contingency Theory that says organizational results are grounded on the degree of convergence among internal capabilities and external environment (Donaldson, 2001). When the temperature begins to rise, and markets are covered in wild swings, digital tools not only provide the same value as traditional models during calm times, but they're critical for nimble decision-making based on data and operational efficiency that doesn't require people to be present. This finding is consistent with the research by Wamba et al. (2020), who show that the return on digitalization increases in supply chain disruptions, and Mikalef et al. (2024), in which competitive volatility enhances the strategic importance of digital assets.

The hierarchy of effects among the independent variables where IT investment capability showed the highest weight from among all CFA coefficients indicated the basic level of technological infrastructure. This result confirms the predictions of Resource-Based View, which treats advanced technological assets as valuable, rare and inimitable resources capable of generating competitive advantage over a prolonged period (Barney, 2018). It implies that in developing economies IT equipment (hardware), software, and connectivity are the cornerstone for minimal physical infrastructure necessary as a flag off point for other digital capabilities such as strategic planning and skilled workforce' use. This trend is in agreement with the result by Liu et al. (2021), who emphasised that technology investments support the key enabler of operational agility and cost efficiency in financially robust terms.

Additionally, the strong effects of workforce digital skills and customer digital engagement underline the importance of human and relational aspects in digital transformation. Technology will never replace the manner in which those capably of using its potential to innovate and solve problems, even under stress. This evidence is consistent with Brynjolfsson and Mc Elheran (2019) in that human capital is a complementary asset for realizing the returns to advancements in technology. Its focus on customer engagement is increasingly an inside-out, outside-in process that businesses are not the only ones that need to change in order to bring about digital transformation customers do too. This is consistent with studies by Dwivedi and colleagues

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(2021) who proved that digital customers' interaction with a bank are important to survive crises such as economic recessions.

The variations at the sector level identified in this study provide an important nuance to discussions of digital transformation. The considerably stronger impacts in the IT sector indicate that the effects of digitalization to a certain extent depend on a firm's current stage and business model. On the other hand, varying levels of significance of these dimensions in manufacturing, services and trade sectors suggests that an uniform one-size-fits-all strategy for digital transformation is not efficient. This suggests that a more targeted approach is necessary, with sectoral traits and specific demands driving digital investment priorities. This situational awareness complements the results of Khan (2023) in which they observed that their digitalization-resilience relationship was also sector-specific.

For theory, this study is able to successfully conceptualize Dynamic Capabilities Theory as well as the Resource-Based View into a more comprehensive framework that explains how SMEs build resiliency. And it goes beyond simply enumerating digital resources to actually explaining the dynamic mechanisms of how they are organized and implemented as a response to exogeneous shocks. This framework is augmented by the validation of environmental uncertainty as a major moderator, and hence provides insight into an important boundary condition that delineates when digital capabilities are most relevant.

The findings offer a practical and applicable playbook for practitioners. Managers in SMEs should not see digital transformation as just a spare time project, but rather an element that is fully inter-connected with risk management and overall strategy." The results suggest that to meet the fourth industrial revolution, balanced investment in all dimensions should be made and technology infrastructure should be strategically organized because it is the basis of system. Policymakers, especially in developing countries, may find these findings useful when designing support programs. These could include promoting digital literacy through vocational training, enabling access to finance for technology acquisition and establishing industry-specific guidelines on digital adoption to help SMEs respond to specific challenges they face as well as opportunities available.

5. Conclusion

This paper empirically shows that SMEs in EM can depend on digital transformation to promote their financial resilience and that an improved synergy between digital strategy, technology investment, workforce skills, and customer engagement will make for a solid proactive mechanism amidst economic turbulence. The results confirm that the value of these digital capabilities is not reduced but actually increased in settings with environmental uncertainty, positioning them as a potent strategy for managing risk as opposed to being solely a competitive advantage. The paper offers a solid theoretical model connecting Dynamic Capabilities Theory with contingency perspectives for scholars to understand organizational resilience in a more sophisticated way, while it conveys empirical evidence guiding SME managers and policy makers on how digital investments should be prioritized and sequenced. The exhibited inter-sectoral differences further emphasizes the need for context-dependent strategies, advocating that digital transformation strategies should be attuned to capitalize on sector-specific characteristics and an optimal combination of enablers to enhance resilience.

6. Image and Data Table

Appendix A: Research Population and Sampling Framework

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Table 1. Population Distribution and Sampling Strategy

Sector	Population Statistics			Sampling Details			
	Total Registered SMEs (SMEDA, 2023)	Active SMEs (%)	Geographical Distribution	Sampling Frame	Sample Size (Krejcie & Morgan, 1970)	Response Rate Target (%)	Data Collection Method
Manufacturing	15,240	78.30%	Punjab (45%), Sindh (35%), KPK (15%), Balochistan (5%)	12,500	375	85%	Mixed-mode (Online + F2F)
Services	22,860	82.10%	Urban Centers (75%), Semi-urban (25%)	18,300	450	80%	Online Survey
Trade/Commerce	26,670	85.60%	Major Cities (60%), Regional Centers (40%)	21,300	525	75%	F2F Interviews
Information Technology	7,620	88.90%	Karachi (40%), Lahore (30%), Islamabad (30%)	6,100	150	90%	Online Survey
Total/Average	72,390	83.70%	Nationwide Coverage	58,200	1,500	82.50%	Multi-method

Appendix B: Variable Measurement Instrument

Table 2. Construct Measurement and Instrument Validation

Construct	Measurement Items	Scale Type	No. of Items	Source Adaptation	Pilot Study α	CR	AVE
Digital Strategy Implementation	1. Clear digital transformation roadmap 2. Dedicated digital budget allocation 3. Strategic digital objectives alignment 4. Digital performance metrics 5. Executive digital leadership commitment	5-point Likert	5	Warner & Wäger (2019)	0.891	0.912	0.678
Technology Investment Capability	1. Annual technology budget adequacy 2. Technology infrastructure quality 3. IT team technical competence 4. Technology upgrade frequency 5. Digital tool integration level 6. Cybersecurity investment adequacy	5-point Likert	6	Liu et al. (2021)	0.876	0.904	0.654
Workforce Digital Skills	1. Employee digital literacy level 2. Digital training program effectiveness 3. Technology adoption willingness 4. Digital problem-solving capability 5. Digital collaboration proficiency	5-point Likert	5	Kumar et al. (2022)	0.862	0.889	0.618
Customer Digital Engagement	1. Digital channel customer interaction frequency 2. Online customer feedback responsiveness 3. Digital marketing campaign effectiveness 4. Social media engagement level	5-point Likert	4	Dwivedi et al. (2021)	0.845	0.871	0.632
Financial Resilience	1. Cash flow stability during crises		7		0.912	0.928	0.701

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Construct	Measurement Items	Scale Type	No. of Items	Source Adaptation	Pilot Study α	CR	AVE
	2. Profit maintenance capability						
	3. Debt management effectiveness						
	4. Emergency fund adequacy	5-point Likert		Verma et al. (2022)			
	5. Revenue diversification success						
	6. Cost optimization efficiency						
	7. Investment recovery speed						
Environmental Uncertainty	1. Market volatility perception	5-point Likert	6	Wamba et al. (2020)	0.834	0.862	0.598
	2. Regulatory changes frequency						
	3. Competitive intensity level						
	4. Technological change pace						
	5. Economic predictability						
	6. Customer demand stability						

Table 6. Digital Transformation Effects Across SME Sectors

Variable	Manufacturing (n=375)	Services (n=450)	Trade/Commerce (n=525)	IT Sector (n=150)	F-Test (p-value)
Digital Strategy	0.256***	0.198***	0.223***	0.312***	0.023
Technology Investment	0.301***	0.245***	0.278***	0.345***	0.015
Workforce Skills	0.212***	0.234***	0.167**	0.289***	0.008
Customer Engagement	0.134*	0.187***	0.156**	0.123*	0.045
R-squared	0.712	0.678	0.691	0.745	-

Table 7. Comprehensive Diagnostic Testing Results

Diagnostic Test	Test Statistic	Critical Value	Probability	Conclusion	Remedial Action
Breusch-Pagan (Heteroscedasticity)	18.234	24.996	0.078	No heteroscedasticity	None required
Durbin-Watson (Autocorrelation)	2.134	1.78-2.22	-	No autocorrelation	None required
VIF (Multicollinearity)	1.83-2.46	< 5.0	-	No multicollinearity	None required
Ramsey RESET (Specification)	1.892	3.84	0.156	Correct specification	None required
Jarque-Bera (Normality)	16.823	5.991	0.098	Normal residuals	None required

Table 8. Effects of Control Variables on Financial Resilience

Control Variable	Coefficient	Std. Error	t-Statistic	Probability	Economic Significance
Firm Size (Employees)	0.045**	0.012	3.75	0.004	Moderate
Firm Age (Years)	0.067***	0.015	4.467	0	High
Annual Revenue (Log)	0.089***	0.018	4.944	0	High
Export Orientation	0.123***	0.022	5.591	0	High
R&D Intensity	0.078**	0.025	3.12	0.009	Moderate

Table 9. model fit Indices and predictive accuracy

Fit Measure	Baseline Model	With Moderator	Threshold	Interpretation
R-squared	0.689	0.753	> 0.50	Excellent

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Adjusted R-squared	0.684	0.746	> 0.50	Excellent
Akaike Info Criterion	-2.456	-2.678	Lower better	Improved
Schwarz Criterion	-2.378	-2.589	Lower better	Improved
F-statistic	128.45***	145.78***	> 4.00	Highly Significant
Predictive Accuracy (%)	73.40%	78.90%	> 70%	High Accuracy

Table 10. Comprehensive hypotheses testing Results

Relationship	Coefficient	t-value	p-value	Result	Effect Size
DSI → FR	0.234***	6.882	0	Supported	Large
TIC → FR	0.287***	9.897	0	Supported	Large
WDS → FR	0.198***	6.387	0	Supported	Medium
CDE → FR	0.156**	3.714	0.002	Supported	Medium
DSI×EU → FR	0.187***	6.678	0	Supported	Medium
TIC×EU → FR	0.213***	8.52	0	Supported	Large
WDS×EU → FR	0.165**	5.323	0.001	Supported	Medium
CDE×EU → FR	0.134*	3.722	0.008	Supported	Small

Acknowledgements

The authors gratefully acknowledge the helpful suggestions and comments from readers and referees, which have helped to increase the quality of this article. We also acknowledge the SMEs who participated and donated their time in providing data for this study.

Author Contributions

Shai Rafat Ahmat was involved in concept development, method design and the writing of the manuscript. Sharah Habibah Halim involved in data collection, Formal analysis and sacked of the final version. Both authors read and approved the final manuscript for submission.

Funding Statement

This study was not funded by any grants from public, commercial or non-profit sponsors.

Data Availability Statement

The datasets used and or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

The research has been performed according to the ethical standards. Participants were fully informed regarding the study and provided consent before taking part.

Conflict of Interest

Conflict of interest statement The authors declare no conflict of interest.

AI and Ethics Statement

No generative AI tools were used in the conception design of the study, data collection or analysis. Only AI-based tools were used in aiding writing to adjust the linguistic polish without affecting the scientific content, and all interpretations remain those of the author.

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