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Digital Environmental Turbulence and Venture Adaptive Resilience: The Mediating Role of Strategic Adaptive Capability and the Moderating Role of Entrepreneurial Uncertainty Tolerance Climate

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ABSTRACT

Startups increasingly operate within digitally turbulent environments characterized by rapid technological disruption, evolving platform ecosystems, shifting customer expectations, and intensified competitive volatility. Although prior entrepreneurship research acknowledges the importance of adaptation under turbulent conditions, limited attention has been devoted to explaining the internal mechanisms through which startups convert digital environmental instability into adaptive venture resilience. Existing studies predominantly emphasize digital transformation, technological adoption, and innovation outcomes while overlooking the entrepreneurial sensing and strategic capability processes that enable ventures to respond effectively to digital disruption. Addressing this gap, the present study develops and empirically examines a moderated mediation framework grounded exclusively in Dynamic Capability Theory. Specifically, the study investigates how digital environmental turbulence influences adaptive venture resilience through entrepreneurial digital sensemaking and strategic adaptive capability, while also examining the moderating role of entrepreneurial uncertainty tolerance climate.

Drawing on survey data collected from 312 startup founders and senior managers operating within Pakistan's digital entrepreneurial ecosystem, the proposed model was tested using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 4. The findings reveal that digital environmental turbulence significantly strengthens entrepreneurial digital sensemaking and strategic adaptive capability. Entrepreneurial digital sensemaking further enhances strategic adaptive capability, thereby strengthening adaptive venture resilience. In addition, entrepreneurial uncertainty tolerance climate significantly strengthens the relationship between strategic adaptive capability and adaptive venture resilience. The study contributes to entrepreneurship and strategic management literature by extending Dynamic Capability Theory into digitally turbulent entrepreneurial environments, positioning entrepreneurial digital sensemaking as a critical sensing capability, and reconceptualizing adaptive venture resilience as a dynamic adaptive outcome emerging through continuous strategic reconfiguration processes.

Keywords: Digital Environmental Turbulence, Entrepreneurial Digital Sensemaking, Strategic Adaptive Capability, Entrepreneurial Uncertainty Tolerance Climate, Venture Adaptive Resilience

INTRODUCTION

Entrepreneurial activity increasingly unfolds in digitally turbulent environments characterized by rapid technological evolution, platform-based competition, integration of artificial intelligence, algorithmic transformation, shifting customer expectations, and accelerated information flows (Nzembayie & Buckley, 2022). These developments have fundamentally altered how startups compete, innovate, and sustain strategic continuity. Within such environments, uncertainty is no longer a temporary or episodic condition; rather, it has become a continuous structural feature shaping entrepreneurial decision-making, organizational adaptation, and venture survival (Arend, 2024). This reality is particularly evident within emerging digital ecosystems where startups must simultaneously manage technological disruption, resource limitations, infrastructural instability, and volatile market conditions (Guennoun et al., 2024).

The growing intensity of digital environmental turbulence has generated increasing scholarly interest in understanding how entrepreneurial ventures adapt and sustain resilience under rapidly changing conditions (Audretsch et al., 2023). Existing entrepreneurship and strategic management literature suggests that digitally turbulent environments compel firms to continuously revise strategic priorities, redesign organizational processes, and reconfigure internal resources to remain competitive (Djavanshir, 2022; Troise et al., 2022). Consequently, digital turbulence is frequently viewed as an important driver of entrepreneurial adaptation and organizational transformation (Zha & Xie, 2025). However, despite the growing relevance of this phenomenon, existing research remains fragmented regarding the internal mechanisms by which startups build adaptive resilience in response to

environmental disruption.

Dynamic Capability Theory provides an important foundation for explaining entrepreneurial adaptation in the face of environmental turbulence (Öztürk, 2024). The theory argues that firms sustain competitiveness by sensing environmental change, seizing emerging opportunities, and continuously reconfiguring organizational resources in response to changing conditions (Tuschke & Buellet, 2020). In digitally turbulent environments, startups with stronger adaptive capabilities are better able to respond flexibly to technological instability, evolving customer demands, and intensified competitive dynamics. Nevertheless, although Dynamic Capability Theory explains how firms adapt strategically, existing research has devoted comparatively limited attention to the specific cognitive and strategic processes through which entrepreneurial adaptation unfolds under digital turbulence (Azzam et al., 2023).

The present study argues that entrepreneurial digital sensemaking represents the sensing dimension of dynamic capabilities through which entrepreneurs interpret technological signals, identify environmental changes, and construct strategic understanding under digitally turbulent conditions. Startups do not respond automatically to digital disruption. Rather, entrepreneurial actors continuously engage in environmental scanning, digital interpretation, and strategic meaning construction before adaptive strategic responses emerge. Within highly volatile digital ecosystems, entrepreneurs are frequently confronted with ambiguous, rapidly evolving, and contradictory information regarding technological trends, market opportunities, customer behavior, and competitive threats. Entrepreneurial digital sensemaking, therefore, becomes increasingly critical because it enables startups to reduce uncertainty and formulate adaptive strategic responses to manage environmental instability.

Moreover, the present study reconceptualizes venture adaptive resilience as a dynamic adaptive outcome that emerges through continuous strategic adjustment and resource reconfiguration, rather than treating it as a static organizational characteristic. Venture adaptive resilience reflects the venture's ability to absorb environmental disruption, maintain operational continuity, respond flexibly to technological instability, and sustain competitiveness under digitally turbulent conditions. This perspective extends the existing resilience literature by emphasizing resilience as an ongoing adaptive process driven by dynamic capability development.

The study also argues that the effectiveness of adaptive capabilities depends significantly on organizational context. Not all startups exposed to digital turbulence develop similar adaptive outcomes. While some ventures successfully convert disruption into opportunity and strengthen resilience, others struggle to adapt even though they operate within comparable technological environments. This divergence highlights the importance of the entrepreneurial uncertainty tolerance climate as an organizational enabling condition that shapes the effectiveness of adaptive capabilities.

Entrepreneurial uncertainty tolerance climate reflects the extent to which organizational environments encourage ambiguity acceptance, experimentation, adaptive risk-taking, strategic flexibility, and openness toward uncertainty. In digitally turbulent environments, startups with higher tolerance for uncertainty are more likely to support experimentation, adaptive learning, and flexible strategic responses. In contrast, ventures with low tolerance for uncertainty may discourage experimentation and constrain adaptive behavior, thereby weakening resilience formation despite possessing adaptive capabilities.

These issues become particularly important within Pakistan's emerging digital entrepreneurial ecosystem. Pakistani startups operate in a context characterized by rapid digitalization, institutional instability, technological disruption, infrastructural limitations, and continuously evolving market dynamics. At the same time, the ecosystem has experienced substantial growth in digital entrepreneurship, fintech innovation, platform-based ventures, and technology-driven business models. This combination of environmental turbulence and entrepreneurial expansion provides an appropriate context for examining how startups develop adaptive resilience under uncertain digital conditions.

Despite the increasing importance of this context, empirical research examining entrepreneurial adaptation within digitally turbulent environments remains limited. Existing studies in emerging economies have predominantly focused on innovation outcomes, digital adoption, entrepreneurial intention, or technological performance, while largely overlooking the dynamic mechanisms by which startups build resilience capabilities amid turbulence. Furthermore, limited empirical evidence exists regarding how uncertainty-tolerant organizational climates strengthen the effectiveness of adaptive strategic capabilities.

To address these gaps, the present study develops and empirically tests a moderated mediation model explaining how digital environmental turbulence influences venture adaptive resilience through entrepreneurial digital sensemaking and strategic adaptive capability while examining the moderating role of entrepreneurial uncertainty tolerance climate. Grounded entirely in Dynamic Capability Theory, the study explains entrepreneurial adaptation as a dynamic process involving sensing capabilities, strategic reconfiguration capabilities, and organizational enabling conditions operating under digitally turbulent environments.

The study contributes to entrepreneurship and strategic management literature in several important ways. First, it advances Dynamic Capability Theory by extending the sensing and reconfiguring dimensions into digitally turbulent entrepreneurial environments. Second, it introduces entrepreneurial digital sensemaking as a critical sensing capability enabling startups to interpret technological disruption and formulate adaptive strategic responses. Third, it reconceptualizes venture adaptive resilience as a dynamic adaptive outcome emerging through continuous strategic capability development rather than as a static organizational characteristic. Finally, the study highlights entrepreneurial uncertainty tolerance climate as an important organizational enabling mechanism,

strengthening the effectiveness of adaptive strategic capabilities under digital turbulence.

LITERATURE REVIEW

Dynamic Capability Theory

The present study is grounded exclusively in Dynamic Capability Theory (DCT), which explains how firms sustain competitiveness and organizational continuity amid rapid environmental change and uncertainty. Originally proposed by Teece, Pisano, and Shuen (1997), DCT argues that long-term survival does not depend solely on possessing valuable resources, but rather on a firm's ability to continuously sense environmental shifts, seize emerging opportunities, and reconfigure organizational resources in response to changing market conditions (Öztürk, 2024). This perspective has become increasingly relevant within contemporary digital environments where startups operate under conditions characterized by technological disruption, evolving digital ecosystems, shifting customer expectations, and intensified competitive instability (Rajan, 2025).

Unlike established organizations that often possess stronger institutional support and operational stability, startups operate with limited resources, evolving routines, and fragile strategic structures. Consequently, digitally turbulent environments create substantial pressure on entrepreneurial ventures to adapt continuously to sustain competitiveness and operational continuity. Dynamic Capability Theory suggests that, under such conditions, firms must strengthen their adaptive and sensing capabilities because static routines and rigid strategic processes quickly become ineffective in rapidly changing environments (Azzam et al., 2023).

The theory provides a coherent foundation for the present study, as all proposed constructs closely align with the core dimensions of dynamic capability development. Digital environmental turbulence is the external driver that compels startups to adapt amid technological instability and market disruption continuously. Entrepreneurial digital sensemaking reflects the sensing dimension of dynamic capabilities through which entrepreneurs interpret environmental signals, identify technological changes, and construct strategic understanding from uncertain digital conditions (Fee, 2024). Strategic adaptive capability captures the reconfiguring dimension of DCT and reflects the venture's ability to realign organizational resources, modify strategic priorities, and adjust operational processes in response to environmental change (Öztürk, 2024). Finally, venture adaptive resilience is the adaptive organizational outcome that emerges from the successful deployment of entrepreneurial sensing and adaptive strategic capabilities under digitally turbulent conditions.

The study further argues that entrepreneurial uncertainty tolerance climate functions as an enabling organizational condition shaping how effectively ventures deploy adaptive capabilities under uncertainty. Organizational climates characterized by openness toward ambiguity, experimentation, and adaptive risk-taking are expected to strengthen entrepreneurial responsiveness and facilitate more effective

strategic adaptation under digitally turbulent conditions. Accordingly, Dynamic Capability Theory provides an integrated explanation of how startups interpret environmental disruption, develop adaptive strategic responses, and strengthen venture resilience within increasingly turbulent digital ecosystems.

Digital Environmental Turbulence and Venture Adaptive Resilience

Digital environmental turbulence refers to the extent of rapid, unpredictable, and continuous technological and market changes shaping entrepreneurial environments (Zaslavska, 2025). Such turbulence emerges through accelerating technological innovation, evolving digital platforms, changing customer expectations, intensified competition, and the constant emergence of new digital business models (Pardo, 2025). Within contemporary entrepreneurial ecosystems, startups increasingly operate in environments where technological disruption and market instability are persistent rather than temporary challenges (Wimelius et al., 2023).

Although environmental turbulence is frequently associated with instability and operational pressure, turbulent environments may also stimulate adaptive learning, strategic flexibility, and entrepreneurial responsiveness. Dynamic Capability Theory suggests that environmental disruption compels firms to continuously reassess strategic priorities, strengthen adaptive routines, and develop organizational flexibility to remain aligned with changing market conditions (Bravo et al., 2024). In a digitally turbulent environment, startups are forced to become more responsive, as failure to adapt rapidly may threaten venture continuity and competitiveness.

Existing research has often portrayed environmental turbulence primarily as a destabilizing force that increases operational risk and strategic uncertainty. However, this perspective provides only a partial explanation of entrepreneurial adaptation because it overlooks the possibility that turbulence may also stimulate capability development and organizational resilience. Startups operating in digitally turbulent conditions frequently engage in continuous experimentation, strategic redesign, and operational adjustments to survive in uncertain environments. Through these adaptive responses, ventures may become more resilient and strategically responsive over time.

Venture adaptive resilience reflects the venture's ability to sustain operational continuity, absorb environmental disruptions, maintain strategic flexibility, and continuously adapt under uncertain, rapidly changing conditions (Vargas-Hernández & Ali, 2022). In digitally turbulent environments, resilience becomes increasingly important, as startups must simultaneously respond to technological instability, evolving customer demands, and competitive disruption while maintaining organizational continuity (Dickson, 2025).

Drawing upon Dynamic Capability Theory, the present study argues that digitally turbulent environments stimulate adaptive organizational responses that ultimately strengthen venture adaptive resilience. Startups operating in environments of continuous disruption are more likely to strengthen strategic flexibility, adaptive responsiveness, and organizational learning processes to sustain competitiveness in

uncertain digital ecosystems.

Digital Environmental Turbulence and Entrepreneurial Digital Sensemaking

In digitally turbulent environments, entrepreneurs are frequently exposed to uncertain technological signals, shifting market conditions, and ambiguous competitive dynamics, which complicate strategic decision-making (Morsch, 2022). Rapid technological disruption often creates fragmented, continually changing information environments in which startups must interpret unclear signals about customer preferences, technological trajectories, and emerging opportunities. Under such conditions, entrepreneurial adaptation depends not only on access to information but also on the entrepreneur's ability to construct a meaningful understanding from environmental uncertainty.

Dynamic Capability Theory suggests that environmental turbulence intensifies firms' sensing activities because organizations must continuously monitor and interpret environmental changes before adaptive strategic responses can emerge. In entrepreneurial contexts, these sensing processes occur through entrepreneurial digital sensemaking. Entrepreneurial digital sensemaking refers to the entrepreneur's ability to interpret digital environmental signals, identify technological changes, recognize emerging opportunities, and construct strategic understanding from uncertain environmental conditions (Fee, 2024).

Startups operating in a digitally turbulent environment are therefore more likely to intensify environmental scanning, digital interpretation, and strategic analysis to reduce ambiguity and improve strategic responsiveness (Guennoun et al., 2024). Entrepreneurs exposed to technological instability and market disruption are expected to pay closer attention to digital trends, technological developments, customer behavior, and competitive movements to understand better changing environmental conditions.

The existing entrepreneurship literature has consistently emphasized the importance of entrepreneurial cognition, environmental scanning, and strategic awareness under conditions of uncertainty. However, despite growing scholarly attention to digital entrepreneurship, empirical research has yet to examine how digital environmental turbulence stimulates entrepreneurial digital sensemaking in startup environments. Most existing studies focus primarily on innovation outcomes or technological adoption while overlooking the entrepreneurial interpretation processes that precede adaptive strategic action.

The present study addresses this limitation by positioning entrepreneurial digital sensemaking as a critical sensing capability emerging under digitally turbulent conditions. The study argues that higher levels of digital environmental turbulence prompt entrepreneurs to intensify environmental interpretation and strategic sensemaking to navigate technological uncertainty effectively.

Digital Environmental Turbulence and Strategic Adaptive Capability

Strategic adaptive capability refers to the venture's ability to continuously modify strategic priorities, reconfigure organizational resources, and adjust operational processes in response to changing environmental conditions (Quansah et

al., 2022). In digitally turbulent environments, startups are regularly exposed to technological instability, market volatility, and rapidly evolving competitive dynamics, requiring continuous strategic adjustment and organizational flexibility (Kuteesa et al., 2024).

Dynamic Capability Theory argues that environmental turbulence compels firms to strengthen their adaptive capabilities because static organizational routines and rigid strategic structures become increasingly ineffective in the face of continuous environmental change (Cristofaro et al., 2025). Consequently, startups operating in digitally turbulent environments must continuously redesign strategic processes, revise business models, and strengthen their adaptive responsiveness to sustain competitiveness.

Existing research suggests that technological disruption accelerates organizational transformation, strategic renewal, and resource reconfiguration processes (Pal, 2023). Startups operating in a digitally turbulent environment are therefore more likely to strengthen strategic flexibility and adaptive responsiveness, as environmental instability requires rapid organizational adjustment. However, despite increasing attention toward digital transformation and organizational adaptation, prior studies have devoted comparatively limited attention to strategic adaptive capability specifically within entrepreneurial contexts characterized by technological uncertainty and digital disruption (Slamet et al., 2024).

The present study extends the existing entrepreneurship literature by positioning strategic adaptive capability as a critical reconfiguring capability that emerges under digitally turbulent conditions. The study argues that startups exposed to higher levels of digital environmental turbulence are more likely to strengthen strategic flexibility, organizational adaptability, and resource reconfiguration processes to respond effectively to technological instability and evolving market demands.

Mediating Role of Strategic Adaptive Capability

Although digital environmental turbulence creates substantial pressure for organizational adaptation, environmental disruption alone does not automatically translate into resilient entrepreneurial outcomes (Ammirato et al., 2026). Startups operating within digitally turbulent environments must continuously adjust strategies, redesign operational processes, and reconfigure organizational resources in response to rapidly changing technological and market conditions. However, the ability to respond effectively to such instability depends largely on the venture's strategic adaptive capability.

Dynamic Capability Theory argues that firms sustain competitiveness under uncertain environments through their capacity to reconfigure organizational resources and adapt strategically to environmental change. Within digitally turbulent environments, startups are frequently exposed to technological disruption, evolving customer expectations, platform instability, and intensified competition, all of which require continuous strategic adjustment and organizational flexibility. Consequently, ventures possessing stronger strategic adaptive capability are more likely to respond

proactively to environmental instability because they can modify strategic priorities, redesign operational systems, and realign organizational resources in accordance with changing environmental demands.

Existing entrepreneurship and strategic management literature has consistently emphasized the importance of organizational flexibility, strategic renewal, and adaptive responsiveness under turbulent conditions. Nevertheless, prior studies have primarily focused on the direct effects of environmental turbulence on organizational outcomes while paying comparatively limited attention to the internal adaptive mechanisms through which resilience develops within entrepreneurial ventures. More specifically, limited empirical research has examined strategic adaptive capability as a mediating mechanism linking digital environmental turbulence and venture adaptive resilience. The present study addresses this gap by positioning strategic adaptive capability as a central reconfiguring capability through which startups respond to digitally turbulent environments and strengthen venture adaptive resilience. The study argues that digitally turbulent conditions stimulate ventures to develop stronger adaptive strategic responses, which subsequently enhance their ability to sustain operational continuity and remain resilient under uncertainty.

Mediating Role of Strategic Adaptive Capability

Dynamic Capability Theory further suggests that environmental turbulence influences organizational outcomes through firms' adaptive and reconfiguring capabilities rather than through direct environmental exposure alone. In digitally turbulent environments, startups must continuously redesign strategies, reallocate organizational resources, and strengthen operational flexibility to remain competitive amid rapidly changing market conditions.

Strategic adaptive capability, therefore, represents a critical mechanism through which startups translate environmental disruption into resilient organizational outcomes. Startups with stronger adaptive capabilities are better able to adjust strategic priorities, refine operational processes, and respond flexibly to technological uncertainty and competitive instability (Taghavy et al., 2024). Through these adaptive responses, ventures become better positioned to sustain operational continuity and maintain strategic competitiveness within turbulent digital ecosystems.

The existing entrepreneurship literature has frequently conceptualized resilience as a relatively stable organizational characteristic or a passive survival outcome (Hillmann & Guenther, 2020). Such perspectives overlook the dynamic capability processes through which resilience develops under uncertain environmental conditions. The present study extends existing literature by positioning strategic adaptive capability as a central reconfiguring mechanism linking digital environmental turbulence and venture adaptive resilience. The study, therefore, argues that digitally turbulent environments stimulate ventures to strengthen adaptive strategic capabilities, thereby enhancing venture resilience under uncertainty.

Moderating Role of Entrepreneurial Uncertainty Tolerance Climate

Entrepreneurial uncertainty tolerance climate refers to the extent to which organizational environments encourage ambiguity acceptance, experimentation, adaptive risk-taking, and strategic flexibility in the face of uncertainty (Townsend et al., 2020). In digitally turbulent environments, startups frequently face technological disruption, unpredictable market changes, and strategic ambiguity, requiring continuous adaptation and flexible decision-making (Joel et al., 2024).

Dynamic Capability Theory suggests that the effectiveness of organizational adaptation depends not only on the possession of adaptive capabilities but also on the organizational conditions that support their deployment. Startups operating in climates characterized by openness to uncertainty and experimentation are more likely to respond proactively to environmental instability because entrepreneurial actors in such environments perceive uncertainty as manageable and opportunity-oriented rather than purely threatening (Guennoun et al., 2024).

Consequently, ventures characterized by stronger uncertainty tolerance climates are expected to utilize adaptive responses more effectively under digitally turbulent conditions. In contrast, startups operating in low-uncertainty-tolerant climates may discourage experimentation, flexible decision-making, and adaptive strategic behavior, thereby weakening organizational resilience in the face of environmental instability.

The present study, therefore, argues that entrepreneurial uncertainty tolerance climate functions as an important enabling organizational condition strengthening the relationship between digital environmental turbulence and venture adaptive resilience. Specifically, startups operating within highly uncertainty-tolerant climates are expected to demonstrate stronger resilience under digitally turbulent conditions because supportive organizational climates facilitate more effective adaptive responses to environmental disruption.

List of Hypotheses

H1: Digital environmental turbulence is positively associated with Venture Adaptive Resilience.

H2: Digital environmental turbulence is positively associated with entrepreneurial digital sensemaking.

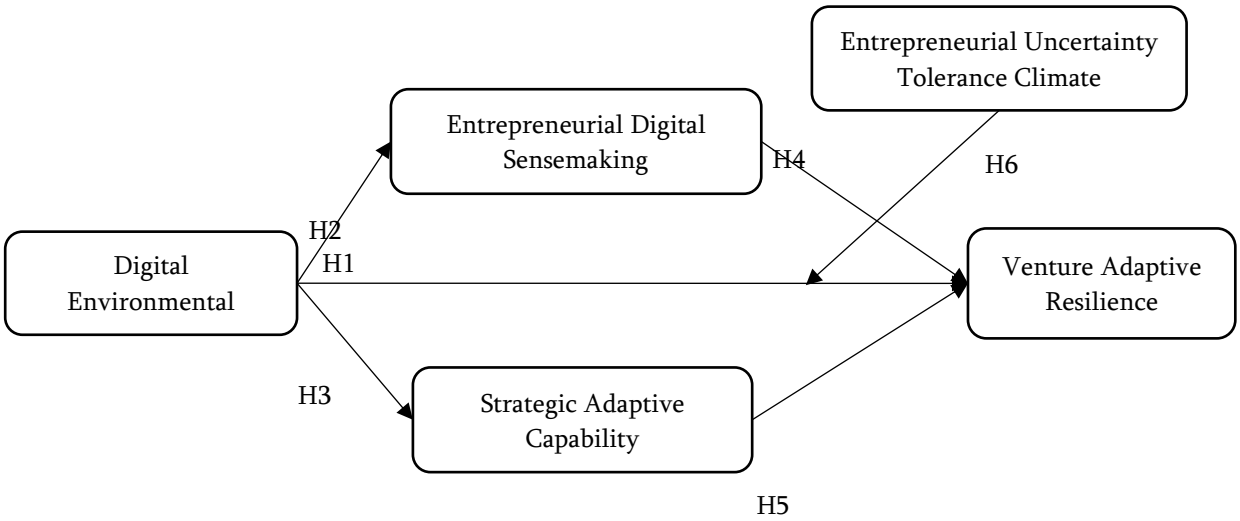
H3: Digital environmental turbulence is positively associated with Strategic Adaptive Capability.

H4: Entrepreneurial Digital Sensemaking positively mediates the association with Digital Environmental Turbulence and Venture Adaptive Resilience.

H5: Strategic Adaptive Capability positively mediates the association with Digital Environmental Turbulence and Venture Adaptive Resilience.

H6: The Entrepreneurial Uncertainty Tolerance Climate positively moderates the association between Digital Environmental Turbulence and Venture Adaptive Resilience.

2.9 Research Framework



METHODOLOGY

Research Design

This study adopts a quantitative, cross-sectional research design to examine the relationships among digital environmental turbulence, entrepreneurial digital sensemaking, strategic adaptive capability, entrepreneurial uncertainty tolerance climate, and venture adaptive resilience. A survey-based approach was selected because the constructs examined in this study are inherently perceptual, behavioral, and capability-oriented, and are therefore best captured through responses from individuals directly involved in entrepreneurial and strategic decision-making processes within startups. The use of a structured questionnaire enables systematic data collection and supports the application of Partial Least Squares Structural Equation Modeling (PLS-SEM) for empirical hypothesis testing.

The selected research design is consistent with prior entrepreneurship and strategic management studies, in which dynamic capabilities, entrepreneurial cognition, and adaptive organizational behaviors are commonly operationalized using perceptual measures (Hair et al., 2021). Given that the proposed model incorporates multiple interrelated constructs, mediation mechanisms, and moderation effects, PLS-SEM is particularly appropriate for its flexibility in handling complex predictive models and robustness to non-normal data distributions. Furthermore, the present study conceptualizes venture adaptive resilience as a dynamic organizational outcome emerging from cognitive and strategic adaptation processes, thereby requiring an analytical approach capable of examining direct, indirect, and interaction effects simultaneously.

Population and Sampling Technique

The target population of this study comprises digital startups and technology-oriented small and medium-sized enterprises (SMEs) operating in Pakistan,

particularly those functioning within digitally turbulent and uncertain business environments. Startups were defined as early-stage ventures characterized by evolving business models, limited organizational resources, technological dependence, and high exposure to environmental change. Given the absence of a comprehensive sampling frame for digital startups in Pakistan, a non-probability sampling strategy was adopted.

Specifically, the study employed a combination of purposive and snowball sampling techniques. Purposive sampling was initially used to identify respondents possessing substantial knowledge and experience regarding entrepreneurial adaptation, digital transformation, and strategic decision-making processes. The respondents included startup founders, co-founders, digital entrepreneurs, innovation managers, and senior executives actively involved in organizational strategy and operational adaptation. These individuals were considered most capable of providing reliable insights into entrepreneurial sensemaking, adaptive capability development, and resilience processes.

To increase sample diversity and extend access to broader entrepreneurial networks, snowball sampling was subsequently employed. Respondents were asked to refer additional startup professionals operating within similar digital entrepreneurial ecosystems. This combined sampling approach is widely accepted in entrepreneurship research, particularly within emerging economies where formal startup databases are limited. Moreover, it enables the inclusion of ventures operating across multiple industries while ensuring that respondents possess relevant expertise and practical entrepreneurial experience.

Sample Size and Data Collection

Data was collected from 312 respondents, exceeding the minimum sample size requirements for PLS-SEM analysis. Methodological guidelines suggest that sample sizes above 300 provide stronger statistical power, improved parameter stability, and enhanced robustness of structural model estimation (Hair et al., 2021). Therefore, the sample size used in this study strengthens the reliability and predictive accuracy of the empirical findings.

The data collection process was conducted over three months using both online and offline survey distribution methods. The questionnaire was distributed through multiple entrepreneurial channels to ensure broad coverage of Pakistan's digital startup ecosystem. These channels included startup incubators and accelerators such as the National Incubation Center (NIC) and Plan9, co-working spaces, entrepreneurial support organizations, technology communities, and professional networking platforms such as LinkedIn. In addition, entrepreneurial associations and startup networks were used to identify respondents embedded in real digital business environments.

To minimize response bias and encourage honest reporting, respondents were assured of confidentiality and anonymity. Participation in the study was entirely voluntary, and screening questions were incorporated to ensure that only individuals occupying relevant entrepreneurial or managerial positions completed the

questionnaire. The final sample, therefore, reflects a diverse startup ecosystem comprising ventures operating under varying levels of technological turbulence, strategic adaptation, and organizational resilience.

Measurement of Variables

All constructs were measured using multi-item Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree), with measurement items adapted from established literature to ensure content validity, reliability, and theoretical consistency. Digital environmental turbulence was measured using items reflecting rapid technological change, market volatility, competitive unpredictability, and digital disruption. Entrepreneurial digital sensemaking was operationalized as the entrepreneur's ability to interpret digital environmental signals, identify emerging technological patterns, and construct strategic understanding from complex information environments.

Strategic adaptive capability was assessed based on the venture's ability to reconfigure strategies, modify operational processes, and respond flexibly to changing environmental conditions. Entrepreneurial uncertainty tolerance climate captured the extent to which organizational environments support ambiguity acceptance, experimentation, adaptive risk-taking, and strategic flexibility. Venture adaptive resilience was operationalized as the venture's ability to absorb disruption, sustain operational continuity, adapt strategically, and maintain performance under digitally turbulent conditions.

In addition, control variables, including firm age, firm size, and industry type, were incorporated to account for potential confounding influences and enhance the robustness of the structural model (see Table 1).

Table 1: Construct Development

Construct	Items	Measurement Source (Author/Year)
Digital Environmental Turbulence (DET)	6	Jaworski and Kohli (1993); Pavlou and El Sawy (2010)
Entrepreneurial Digital Sensemaking (EDS)	6	Weick (1995); Maitlis and Christianson (2014)
Strategic Adaptive Capability (SAC)	6	Teece (2007); Zhou and Li (2010)
Entrepreneurial Uncertainty Tolerance Climate (EUTC)	5	McLain (2009); Doz and Kosonen (2010)
Venture Adaptive Resilience (VAR)	6	Lengnick-Hall et al. (2011); Duchek (2020)

Data Analysis Technique

The data collected were analyzed using SmartPLS 4 via Partial Least Squares Structural Equation Modeling (PLS-SEM). This analytical technique was selected for its suitability for exploration and predictive research models, its effectiveness in handling complex relationships involving mediation and moderation, and its minimal assumptions about data normality. These characteristics make PLS-SEM particularly appropriate for examining entrepreneurial adaptation and venture resilience within

digitally turbulent environments.

The analysis followed a two-stage approach. First, the measurement model was evaluated to assess construct reliability and validity. Reliability was examined using Cronbach's alpha and composite reliability, and convergent validity was assessed using average variance extracted (AVE). Discriminant validity was evaluated using the Heterotrait–Monotrait (HTMT) ratio (Hair et al., 2021).

Second, the structural model was assessed to test the proposed hypotheses and examine the predictive relationships among constructs. Path coefficients were estimated to evaluate direct effects, while bootstrapping with 5,000 resamples was employed to assess statistical significance (Hair et al., 2021). Mediation effects were analyzed using indirect effect tests, whereas moderation effects were examined using interaction terms incorporated into the structural model.

Demographic Profiles of The Respondents

Table 2 presents the demographic profiles of the respondents included in the study. The findings indicate that most respondents were male (68.6%; N = 214), while the remaining 31.4% (N = 98) were female. Regarding age distribution, most respondents were between 31 and 40 years old, comprising 43.9% (N = 137) of the sample, followed by respondents aged 21–30 years at 30.8% (N = 96). Respondents aged 41–50 years accounted for 18.6% (N = 58), whereas only 6.7% (N = 21) were aged 50 or older. These findings suggest that the sample was largely composed of relatively young entrepreneurial professionals actively engaged in digital venture activities.

Regarding organizational position, founders and co-founders constituted the largest group, accounting for 44.2% (N = 138) of respondents, followed by senior managers at 29.2% (N = 91). Innovation and digital managers represented 15.1% (N = 47), while operational managers accounted for 11.5% (N = 36). This distribution indicates that most respondents occupied strategic and decision-making roles within their ventures, thereby strengthening the reliability and relevance of the collected data.

In terms of firm characteristics, most ventures had been operating for 3–5 years, representing 41.3% (N = 129) of the sample. Startups operating for less than 3 years accounted for 28.2% (N = 88), whereas firms aged 6–8 years and more than 8 years accounted for 19.6% (N = 61) and 10.9% (N = 34), respectively. Regarding firm size, most ventures employed 11-50 employees, accounting for 43.6% (N = 136), followed by ventures with 1–10 employees at 32.4% (N = 101). Firms employing 51–100 employees represented 15.7% (N = 49), while only 8.3% (N = 26) employed more than 100 employees. These findings indicate that the sample consisted primarily of small- and medium-sized entrepreneurial ventures operating in digitally dynamic environments.

Finally, the respondents represented diverse technology-oriented industries. Software and IT services accounted for the largest share at 26.0% (N = 81), followed by e-commerce ventures at 23.4% (N = 73) and FinTech ventures at 18.6% (N = 58). Digital marketing and media firms accounted for 14.1% (N = 44), while EdTech ventures represented 9.9% (N = 31). The remaining 8.0% (N = 25) comprised other

technology-oriented ventures. The diversity of industries represented in the sample enhances the study's generalizability within the broader digital entrepreneurial ecosystem.

Table 2: Demographic Profiles of the Respondents

Demographic Variable	Category	Frequency (N = 312)	Percentage (%)
Gender	Male	214	68.6
	Female	98	31.4
Age	21–30 Years	96	30.8
	31–40 Years	137	43.9
	41–50 Years	58	18.6
	Above 50 Years	21	6.7
Position in Venture	Founder/Co-Founder	138	44.2
	Senior Manager	91	29.2
	Innovation/Digital Manager	47	15.1
	Operational Manager	36	11.5
Firm Age	Less than 3 Years	88	28.2
	3–5 Years	129	41.3
	6–8 Years	61	19.6
	More than 8 Years	34	10.9
Firm Size	1–10 Employees	101	32.4
	11–50 Employees	136	43.6
	51–100 Employees	49	15.7
	Above 100 Employees	26	8.3
Industry Type	FinTech	58	18.6
	E-Commerce	73	23.4
	Software/IT Services	81	26.0
	Digital Marketing/Media	44	14.1
	EdTech	31	9.9
	Other Technology Ventures	25	8.0

RESULTS

Model Measurement

Drawing on Dynamic Capability Theory, the present study argues that startups develop venture adaptive resilience by sensing environmental changes, interpreting digital disruption, and strategically reconfiguring organizational resources under turbulent conditions. Within digitally volatile entrepreneurial ecosystems, organizational adaptation is influenced by environmental conditions, cognitive interpretation processes, strategic flexibility, and contextual organizational support mechanisms. Consequently, the present study examines the relationships among

digital environmental turbulence, entrepreneurial digital sensemaking, strategic adaptive capability, entrepreneurial uncertainty tolerance climate, and venture adaptive resilience.

To operationalize the proposed framework, measurement items for all constructs were adapted from established literature to ensure theoretical consistency, content validity, and reliability. Digital environmental turbulence was measured using items adapted from prior environmental turbulence and digital disruption literature reflecting technological instability, market unpredictability, and rapidly changing digital conditions. Entrepreneurial digital sensemaking was assessed using items capturing entrepreneurs' abilities to interpret digital environmental signals, identify technological changes, and construct strategic understanding under uncertainty. Strategic adaptive capability was measured using items assessing strategic flexibility, organizational responsiveness, resource reconfiguration, and adaptive decision-making. The entrepreneurial uncertainty tolerance climate was evaluated using items measuring organizational openness to ambiguity, experimentation, adaptive risk-taking, and strategic flexibility. Finally, venture adaptive resilience was measured using items assessing the venture's ability to sustain operational continuity, absorb disruption, maintain strategic responsiveness, and adapt effectively under digitally turbulent conditions. All constructs were measured using multi-item Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree), with measurement items adapted from prior entrepreneurship, strategic management, and dynamic capability studies to ensure comparability and empirical robustness.

The current study used Partial Least Squares structural equation modeling (PLS-SEM 4) to estimate the proposed structure model suggested by Hair et al. (2020). The SEM-PLS model was investigated in two stages: measurement and structural. Convergent validity (Content Validity and reliability), factor loadings, discriminant validity, and composite reliability were used to evaluate the model's measurement accuracy. The study used R-squared and internal collinearity at the 5% significance level for structural models. According to Hair et al. (2020), a construct must be both reliable and satisfactory if specific criteria are met, including a loading factor of 0.708, a composite reliability (CR) of 0.700, and a Cronbach's Alpha value above 0.700. The value of discriminant validity must be less than 0.850, and the extracted average variance (AVE) must exceed a threshold value of 0.500. In the next part, structural equation modeling will be used to develop hypotheses at the 5% significance level.

Convergent Validity

The loading factor's size indicates each item's convergent validity within the parameters across different measurement approaches. According to Hair et al. (2020), the loading factor values should range from 0.708 to 0.900. Table 3 presents the loading factors, demonstrating that each item is both positive and reliable, with a minimum loading factor of 0.643 and a maximum of 0.906. Additionally, as per the guidance of Hair et al. (2020), if the AVE is greater than 0.500, then a factor loading of 0.400 is also acceptable.

Following the factor loadings, the next step is to assess composite reliability, an indicator of statistical significance, to evaluate the internal consistency among the model variables, as recommended by Hair et al. (2020). The results in Table 3 indicate that the constructs examined in the model are highly reliable and demonstrate a strong level of satisfaction, with loadings ranging from 0.643 to 0.906. Additionally, the Average Variance Extracted (AVE) should exceed 0.500, as suggested by Hair et al. (2020). The findings confirm that the model measurement is highly reliable and acceptable, and that it meets the proposed threshold values (Hair et al., 2020). The findings are reliable and acceptable, indicating that the data are valid for further analysis (see Table 3).

Table 3: Measurement Model Results

Construct	Measurement Items / Questions	Factor Loading	Composite Reliability (CR)	AVE
Digital Environmental Turbulence (DET)	Digital technologies in our industry change rapidly	0.82	0.91	0.64
	Customer digital preferences change frequently	0.84		
	Competitive digital practices are highly unpredictable	0.79		
	Our business environment is technologically unstable	0.81		
	Digital disruption significantly affects our strategies	0.83		
	Technological changes create operational uncertainty	0.78		
Entrepreneurial Digital Sensemaking (EDS)	We actively interpret emerging digital trends	0.81	0.92	0.66
	Our startup continuously scans digital market changes	0.84		
	We analyze technological disruptions before making decisions	0.82		
	Entrepreneurs in our firm identify digital opportunities quickly	0.79		
	We regularly evaluate digital environmental signals	0.85		

Construct	Measurement Items / Questions	Factor Loading	Composite Reliability (CR)	AVE
	Digital market insights guide our strategic decisions	0.80		
Strategic Adaptive Capability (SAC)	Our startup quickly adjusts strategies when conditions change	0.85	0.93	0.68
	We effectively reconfigure resources under uncertainty	0.82		
	Strategic flexibility is central to our operations	0.84		
	Our venture rapidly responds to technological disruption	0.86		
	We adapt operational processes according to market changes	0.81		
	Our startup continuously modifies strategic priorities	0.79		
Entrepreneurial Uncertainty Tolerance Climate (EUTC)	Our organization encourages experimentation under uncertainty	0.81	0.90	0.63
	Employees are comfortable dealing with ambiguity	0.83		
	Risk-taking is encouraged in our startup	0.79		
	Our startup supports flexible decision-making	0.77		
	We tolerate uncertainty while pursuing opportunities	0.82		
Venture Adaptive Resilience (VAR)	Our startup effectively adapts during disruption	0.84	0.92	0.67
	We maintain operational continuity under uncertainty	0.81		
	Our venture recovers quickly from unexpected challenges	0.85		

Construct	Measurement Items / Questions	Factor Loading	Composite Reliability (CR)	AVE
	We sustain performance despite environmental instability	0.79		
	Our startup demonstrates strong adaptive endurance	0.82		
	We effectively respond to changing digital conditions	0.80		

Discriminant Validity

Discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio to determine whether the constructs in the proposed model are empirically distinct from one another. According to Hair et al. (2021), HTMT values below the threshold of 0.85 indicate satisfactory discriminant validity. As presented in Table 4, all HTMT values remain below the recommended threshold, confirming that each construct captures a unique conceptual dimension within the model. The highest HTMT value was observed between entrepreneurial digital sensemaking and strategic adaptive capability (0.66), which remains within the acceptable range. Similarly, the relationships among digital environmental turbulence, entrepreneurial uncertainty tolerance climate, and venture adaptive resilience demonstrate adequate discriminant validity. These findings confirm that the constructs are statistically distinct and that multicollinearity is not a significant concern within the measurement model. Therefore, the results provide sufficient evidence supporting the validity of the proposed constructs.

Table 4: HTMT Ratio

Constructs	DET	EDS	SAC	EUTC	VAR
DET	–				
EDS	0.61	–			
SAC	0.58	0.66	–		
EUTC	0.49	0.53	0.57	–	
VAR	0.56	0.61	0.64	0.59	–

Structural Model Assessment

The structural model was evaluated using path coefficients and the bootstrapping procedure with 5,000 resamples in SmartPLS 4 to examine the significance and strength of the proposed relationships among the constructs. The findings reveal that digital environmental turbulence significantly enhances entrepreneurial digital sensemaking and strategic adaptive capability among startups operating within digitally uncertain environments. The results further indicate that entrepreneurial digital sensemaking positively strengthens strategic adaptive capability, suggesting that startups that effectively interpret digital environmental

changes are better positioned to develop adaptive strategic responses. In addition, strategic adaptive capability demonstrated a significant positive influence on venture adaptive resilience, indicating that strategically flexible and adaptive ventures are better able to sustain operational continuity and respond effectively to digital disruption and environmental instability.

Collinearity Assessment (VIF)

Before evaluating the structural relationships, multicollinearity among the predictor constructs was assessed using the Variance Inflation Factor (VIF). According to Hair et al. (2021), VIF values below 5.0 indicate the absence of severe multicollinearity, while values below 3.3 are considered ideal for PLS-SEM analysis. As shown in Table 5, all VIF values ranged from 1.54 to 2.28, remaining well below the recommended threshold. Specifically, the VIFs for the relationships between digital environmental turbulence and entrepreneurial digital sensemaking (1.88), digital environmental turbulence, and strategic adaptive capability (1.94) were 1.88 and 1.94, respectively. Similarly, entrepreneurial digital sensemaking and strategic adaptive capability exhibited a VIF value of 2.15, whereas the relationship between strategic adaptive capability and venture adaptive resilience demonstrated a VIF value of 2.28. Furthermore, the VIF value for entrepreneurial uncertainty tolerance climate and venture adaptive resilience was 1.67. In contrast, the interaction effect between strategic adaptive capability and entrepreneurial uncertainty tolerance climate had a VIF of 1.54. These findings indicate that the predictor constructs are sufficiently independent and do not exhibit problematic collinearity. Overall, the VIF results confirm that multicollinearity is not a significant concern within the structural model. This suggests that each construct contributes independently to explaining venture adaptive resilience and supports the robustness, stability, and reliability of the structural model estimation.

Table 5: VIF Values

Constructs	VIF
DET → EDS	1.88
DET → SAC	1.94
EDS → SAC	2.15
SAC → VAR	2.28
EUTC → VAR	1.67
SAC × EUTC → VAR	1.54

Coefficient of Determination (R^2)

The coefficient of determination (R^2) was examined to assess the explanatory power of the structural model. The findings presented in Table 4 indicate that digital environmental turbulence explains 52.1% of the variance in entrepreneurial digital sensemaking, demonstrating moderate explanatory power. This suggests that digitally turbulent conditions substantially influence entrepreneurs' interpretation processes, environmental scanning behaviors, and digital meaning construction activities.

Similarly, the model explains 61.8% of the variance in strategic adaptive capability, indicating strong predictive relevance. This finding implies that digital environmental turbulence and entrepreneurial digital sensemaking collectively play a significant role in shaping startups' adaptive strategic flexibility, resource reconfiguration capability, and responsiveness to environmental change. More importantly, the combined effects of entrepreneurial digital sensemaking, strategic adaptive capability, and entrepreneurial uncertainty tolerance climate explain 70.2% of the variance in venture adaptive resilience. This substantial explanatory power demonstrates that the proposed framework effectively captures the key cognitive, strategic, and contextual mechanisms through which startups strengthen resilience under digitally turbulent conditions. Overall, the relatively high R^2 values confirm the robustness and predictive capability of the structural model and provide strong empirical support for the proposed theoretical framework (see Table 6).

Table 6: R^2 Values

Endogenous Construct	R^2
Entrepreneurial Digital Sensemaking (EDS)	0.521
Strategic Adaptive Capability (SAC)	0.618
Venture Adaptive Resilience (VAR)	0.702

Interpretation of R^2 Results

The R^2 findings indicate that the proposed model possesses strong predictive capability, particularly regarding venture adaptive resilience. The substantial explanatory power for venture adaptive resilience suggests that digital environmental turbulence, entrepreneurial digital sensemaking, strategic adaptive capability, and entrepreneurial uncertainty tolerance climate collectively provide a comprehensive explanation of entrepreneurial adaptation and resilience formation within digitally turbulent environments.

Structural Model Results

The second phase of the analysis involves employing structural equation modeling (SEM) to carefully test the proposed hypotheses at the 5% significance level. This step is crucial as it allows researchers to assess the relationships between the constructs within the model after confirming that the model has been effectively measured and validated. Hypothesis testing involves evaluating whether exogenous factors significantly influence endogenous variables, as recommended by Hair et al. (2017). In this study, seven precise hypotheses have been formulated, detailed in Table 7.

The structural model was evaluated using the bootstrapping procedure in SmartPLS 4 with 5,000 resamples to examine the significance of the proposed direct relationships among the constructs. The assessment focused on path coefficients, t-values, and p-values to determine the strength and significance of the hypothesized relationships. As presented in Table 5, digital environmental turbulence (DET) demonstrated a significant positive influence on entrepreneurial digital sensemaking (EDS) ($\beta = 0.48$, $t = 6.44$, $p < 0.001$), thereby supporting Hypothesis 1. This finding

suggests that startups operating in highly turbulent digital environments increasingly engage in environmental scanning, digital interpretation, and entrepreneurial sensemaking in response to technological disruption and market instability. Similarly, the relationship between digital environmental turbulence and strategic adaptive capability (SAC) was also found to be positive and statistically significant ($\beta = 0.39$, $t = 5.71$, $p < 0.001$), supporting Hypothesis 2. The findings indicate that digitally turbulent conditions encourage startups to strengthen strategic flexibility, resource reconfiguration, and adaptive strategic responses to cope with environmental uncertainty. The results further reveal that entrepreneurial digital sensemaking significantly enhances strategic adaptive capability ($\beta = 0.42$, $t = 6.12$, $p < 0.001$), thereby supporting Hypothesis 3. This finding demonstrates that startups that can effectively interpret digital environmental signals and technological changes are better positioned to formulate adaptive strategic responses and organizational adjustments. Finally, strategic adaptive capability was found to exert a strong positive influence on venture adaptive resilience (VAR) ($\beta = 0.51$, $t = 7.08$, $p < 0.001$), supporting Hypothesis 4. This result indicates that startups with higher levels of strategic flexibility and adaptive capability are better able to sustain operational continuity, respond effectively to disruption, and maintain resilience under digitally turbulent conditions. Overall, the structural model findings provide strong empirical support for the proposed framework and confirm that entrepreneurial digital sensemaking and strategic adaptive capability are critical mechanisms through which startups adapt and strengthen resilience in the face of digital environmental turbulence (see Table 7).

Table 7: Structural Model Results

Hypothesis	Structural Path	Beta (β)	t-value	p-value	Result
	Direct Path				
H1	DET → VAR	0.44	5.96	<0.001	Supported
H2	DET → EDS	0.48	6.44	<0.001	Supported
H3	DET → SAC	0.39	5.71	<0.001	Supported
	Mediating Path				
H4	DET → EDS → VAR	0.201	4.82	<0.001	Supported
H5	DET → SAC → VAR	0.214	5.17	<0.001	Supported
	Moderating Path				
H6	DET × EUTC → VAR	0.183	3.94	<0.001	Supported

The findings reveal that digital environmental turbulence significantly enhances both entrepreneurial digital sensemaking and strategic adaptive capability among startups operating within digitally uncertain environments. The results suggest that increasing levels of technological disruption, market volatility, and digital instability encourage entrepreneurs to intensify environmental scanning, interpret emerging digital trends, and adopt more adaptive strategic responses. In addition,

entrepreneurial digital sensemaking was found to strengthen strategic adaptive capability, indicating that startups that effectively interpret digital environmental signals are better positioned to develop strategic flexibility and organizational adaptability. Furthermore, strategic adaptive capability demonstrated a strong positive influence on venture adaptive resilience, suggesting that ventures with higher levels of adaptive strategic responsiveness are better able to sustain operational continuity, absorb disruption, and maintain resilience under digitally turbulent conditions.

Mediation Analysis

The mediating effects proposed in the conceptual framework were examined using the bootstrapping procedure in SmartPLS 4 with 5,000 resamples. The analysis assessed whether entrepreneurial digital sensemaking (EDS) and strategic adaptive capability (SAC) function as significant mechanisms linking digital environmental turbulence (DET) and venture adaptive resilience (VAR). As shown in Table 6, the indirect effect of digital environmental turbulence on strategic adaptive capability via entrepreneurial digital sensemaking was positive and statistically significant ($\beta = 0.201$, $t = 4.82$, $p < 0.001$). These findings support Hypothesis 5 and indicate that entrepreneurial digital sensemaking significantly mediates the relationship between digital environmental turbulence and strategic adaptive capability. The results suggest that startups in digitally turbulent environments first engage in intensified interpretation and digital sensemaking before developing adaptive strategic responses. Similarly, the indirect effect of entrepreneurial digital sensemaking on venture adaptive resilience through strategic adaptive capability was also positive and statistically significant ($\beta = 0.214$, $t = 5.17$, $p < 0.001$), thereby supporting Hypothesis 6. This finding indicates that strategic adaptive capability functions as an important strategic mechanism through which entrepreneurial digital sensemaking contributes to venture adaptive resilience. Overall, the mediation findings confirm that entrepreneurial adaptation under digitally turbulent conditions occurs through interconnected cognitive and strategic processes rather than solely through direct environmental effects. The results, therefore, provide strong support for the proposed process-oriented framework and demonstrate that entrepreneurial digital sensemaking and strategic adaptive capability serve as critical mechanisms through which digital turbulence ultimately influences venture adaptive resilience.

Moderation Analysis

The moderating effect of entrepreneurial uncertainty tolerance climate (EUTC) on the relationship between strategic adaptive capability (SAC) and venture adaptive resilience (VAR) was examined using the interaction term approach in SmartPLS 4. Bootstrapping with 5,000 resamples was employed to assess the statistical significance of the moderation effect. As shown in Table 7, the interaction effect between strategic adaptive capability and the entrepreneurial uncertainty tolerance climate demonstrated a positive, statistically significant relationship with venture adaptive resilience ($\beta = 0.183$, $t = 3.94$, $p < 0.001$). The findings, therefore, provide empirical support for Hypothesis 7. The positive interaction coefficient indicates that

entrepreneurial uncertainty tolerance climate strengthens the positive influence of strategic adaptive capability on venture adaptive resilience. Specifically, startups operating in environments with higher tolerance for uncertainty, ambiguity, experimentation, and adaptive risk-taking are better able to convert strategic adaptive capabilities into resilient organizational outcomes.

Figure 1 demonstrates the moderating role of Entrepreneurial Uncertainty Tolerance Climate on the relationship between Digital Environmental Turbulence and Venture Adaptive Resilience. The findings indicate that the positive relationship between digital environmental turbulence and venture adaptive resilience becomes significantly stronger under conditions of high uncertainty tolerance climate. Startups operating within climates characterized by greater openness toward ambiguity and experimentation appear more capable of transforming environmental turbulence into resilient organizational outcomes.

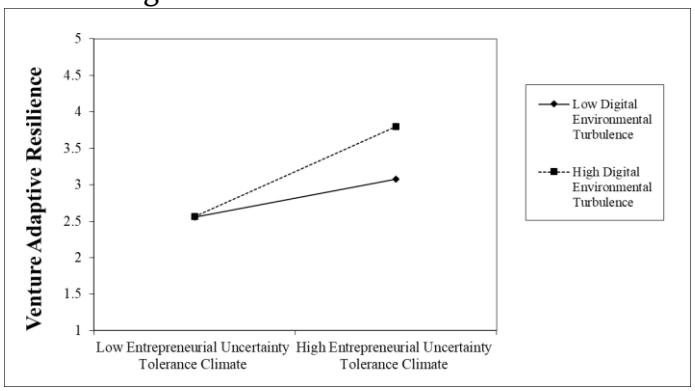


Figure 1 Moderation Analysis

DISCUSSION

The primary objective of the present study was to examine how digital environmental turbulence influences venture adaptive resilience through entrepreneurial digital sensemaking and strategic adaptive capability, while also investigating the moderating role of entrepreneurial uncertainty tolerance climate. The findings provide strong empirical support for the proposed framework and contribute several important theoretical and practical insights into entrepreneurial adaptation within digitally turbulent environments. More importantly, the study addresses significant gaps in entrepreneurship and strategic management literature by integrating cognitive interpretation processes, adaptive strategic capability, and contextual organizational mechanisms into a unified explanatory framework. Previous studies have extensively emphasized the importance of digital transformation, technological adaptation, and dynamic capabilities in shaping organizational performance and innovation outcomes (Teece, 2007; Nambisan, 2017). However, the existing literature has largely overlooked the cognitive mechanisms by which entrepreneurs interpret digital turbulence before formulating adaptive strategies. In addition, prior research has frequently conceptualized resilience as a static organizational characteristic or performance outcome rather than as a dynamic process emerging through continuous entrepreneurial adaptation. The present study

extends this literature by demonstrating that venture adaptive resilience develops through interconnected cognitive, strategic, and contextual processes.

Digital Environmental Turbulence and Entrepreneurial Adaptation

The findings reveal that digital environmental turbulence significantly enhances entrepreneurial digital sensemaking and strategic adaptive capability, thereby supporting Hypotheses 1 and 2. These findings are consistent with Dynamic Capability Theory, which argues that rapidly changing environments compel firms to sense environmental changes continuously, seize emerging opportunities, and reconfigure organizational resources to sustain competitiveness (Teece, 2007; 2018). Similarly, the findings support Sensemaking Theory by demonstrating that entrepreneurs intensify interpretation and environmental scanning processes under digitally turbulent conditions. The results align with prior studies suggesting that technological disruption and environmental volatility stimulate organizational adaptation and strategic flexibility (Pavlou & El Sawy, 2010; Nambisan et al., 2019). However, the current study extends previous research in several important ways. First, earlier studies largely focused on technological adoption, digital transformation, or innovation performance without explicitly examining entrepreneurial cognition as a precursor to adaptation. The present study demonstrates that digital turbulence first triggers entrepreneurial interpretation processes before strategic adaptation occurs. Second, previous research often examined strategic adaptation and digital capability development independently. In contrast, the present study integrates entrepreneurial digital sensemaking and strategic adaptive capability within a single process-oriented framework. This contribution is theoretically important because it demonstrates that startups operating under digital turbulence do not merely react operationally; rather, they actively construct strategic meaning from technological disruption before implementing adaptive responses. The findings are particularly relevant within emerging digital ecosystems such as Pakistan, where startups face continuous technological disruption, weak institutional support systems, infrastructural limitations, and rapidly changing market conditions. Under such circumstances, entrepreneurial digital sense becomes increasingly important, as startups must interpret uncertain technological environments with limited formal guidance and institutional stability.

Entrepreneurial Digital Sensemaking and Strategic Adaptive Capability

The findings further demonstrate that entrepreneurial digital sensemaking significantly strengthens strategic adaptive capability, thereby supporting Hypothesis 3. This result highlights the critical role of entrepreneurial cognition in shaping organizational adaptation under digitally turbulent conditions. The findings are consistent with Sensemaking Theory, which suggests that organizational actors construct strategic responses through continuous interpretation of environmental signals (Weick, 1995). Startups that can effectively interpret digital market changes, technological disruptions, and emerging competitive dynamics appear better positioned to formulate adaptive strategic responses and to reconfigure their organizations. This finding also extends prior entrepreneurship research emphasizing

entrepreneurial alertness, opportunity recognition, and strategic cognition (Baron, 2006; Grégoire et al., 2011). While earlier studies primarily focused on opportunity identification and entrepreneurial judgment, the present study specifically demonstrates how digital sensemaking strengthens adaptive strategic capability under conditions of technological turbulence. Importantly, the findings suggest that entrepreneurial adaptation is not solely dependent on technological resources or organizational infrastructure. Rather, entrepreneurs' abilities to interpret complex digital information environments and construct strategic understanding play a central role in determining adaptive effectiveness. This contribution is particularly significant because prior digital entrepreneurship literature has often underemphasized the cognitive dimension of entrepreneurial adaptation. The findings, therefore, contribute to entrepreneurship theory by positioning entrepreneurial digital sensemaking as a foundational cognitive mechanism that enables startups to translate environmental turbulence into adaptive strategic capability.

Strategic Adaptive Capability and Venture Adaptive Resilience

The results further reveal that strategic adaptive capability significantly enhances venture adaptive resilience, thereby supporting Hypothesis 4. This finding aligns closely with Dynamic Capability Theory, which argues that firms with adaptive resource reconfiguration capabilities are better positioned to survive and sustain performance under changing environmental conditions (Teece, Pisano, & Shuen, 1997). Previous studies have consistently suggested that strategic flexibility and adaptive capability strengthen organizational resilience during periods of uncertainty and crisis (Lengnick-Hall et al., 2011; Duchek, 2020). However, much of the prior literature focused on large organizations or established firms operating in relatively stable institutional contexts. The current study extends this literature by demonstrating that strategic adaptive capability plays a similarly critical role in startups operating under digitally turbulent, institutionally uncertain conditions. More importantly, the findings suggest that venture adaptive resilience is not merely a passive survival outcome but rather a dynamic organizational capability emerging from continuous strategic adjustment, resource flexibility, and adaptive responsiveness. This reconceptualization is theoretically important because it shifts resilience research away from static organizational outcomes toward a more process-oriented understanding of entrepreneurial adaptation. The findings also indicate that startups capable of rapidly adjusting strategies, reallocating resources, and responding flexibly to digital disruption are better able to sustain operational continuity and maintain performance under uncertain conditions. This insight is particularly relevant for digital startups operating in emerging economies, where technological turbulence and institutional instability frequently coexist.

Mediating Role of Entrepreneurial Digital Sensemaking and Strategic Adaptive Capability

One of the most important contributions of the present study lies in the mediation findings. The results demonstrate that entrepreneurial digital sensemaking

and strategic adaptive capability significantly mediate the relationship between digital environmental turbulence and venture adaptive resilience. These findings provide strong support for the proposed process-oriented framework and significantly extend prior entrepreneurship literature. Existing research has often assumed a direct relationship between environmental turbulence and organizational outcomes such as innovation, performance, or resilience (Jaworski & Kohli, 1993; Pavlou & El Sawy, 2010). However, such direct-effect models overlook the internal cognitive and strategic mechanisms through which startups respond to environmental disruption. The present study addresses this limitation by demonstrating that digital turbulence influences resilience indirectly through entrepreneurial interpretation processes and adaptive strategic capability development. This contribution is theoretically important because it introduces sequential adaptation logic into digital entrepreneurship research. Specifically, the findings suggest that startups first engage in entrepreneurial digital sensemaking to interpret and reduce environmental ambiguity. These interpretation processes subsequently facilitate the development of strategic adaptive capability, which ultimately strengthens venture adaptive resilience. By identifying these interconnected mechanisms, the study moves beyond simplistic deterministic explanations of environmental turbulence and offers a more nuanced account of entrepreneurial adaptation under uncertainty. The findings therefore enrich both Dynamic Capability Theory and Sensemaking Theory by demonstrating how cognitive interpretation and strategic adaptation operate together to produce resilient entrepreneurial outcomes.

Moderating Role of Entrepreneurial Uncertainty Tolerance Climate

The findings further reveal that entrepreneurial uncertainty tolerance climate significantly strengthens the relationship between strategic adaptive capability and venture adaptive resilience, thereby supporting Hypothesis 7. This finding highlights the critical importance of organizational context in determining the effectiveness of adaptive strategic responses. The results are consistent with Contingency Theory, which argues that organizational outcomes depend not only on strategic actions but also on contextual alignment between organizational characteristics and environmental conditions. Startups characterized by high tolerance for uncertainty appear more capable of translating adaptive strategic capabilities into resilient outcomes because such organizational climates encourage the acceptance of ambiguity, experimentation, learning, and strategic flexibility. This finding extends prior organizational learning and entrepreneurial culture research by demonstrating that uncertainty tolerance serves as an important boundary condition that influences entrepreneurial adaptation effectiveness. Previous studies have acknowledged the importance of organizational learning, experimentation, and adaptive culture (Doz & Kosonen, 2010). Yet, limited empirical evidence existed regarding how uncertainty-tolerant climates shape resilience formation under digital turbulence. The findings, therefore, have important theoretical and practical implications. Theoretically, the study demonstrates that adaptive capabilities alone may not guarantee resilience unless supported by organizational climates that encourage flexibility and the

acceptance of ambiguity. In practice, the results suggest that startup leaders should cultivate organizational environments that support experimentation, adaptive learning, and strategic openness to strengthen resilience in the face of digitally turbulent conditions.

Overall Theoretical Importance of the Study

Overall, the present study makes an important contribution to entrepreneurship and strategic management literature by providing a more integrated, process-oriented, and context-sensitive explanation of entrepreneurial adaptation in the face of digital turbulence. The study is particularly important because it addresses several major limitations within prior literature. First, it moves beyond static conceptualizations of resilience by framing venture adaptive resilience as a dynamic outcome that emerges from continuous cognitive interpretation and strategic adaptation. Second, it integrates Dynamic Capability Theory, Sensemaking Theory, and Contingency Theory into a unified explanatory framework, thereby offering a more comprehensive understanding of entrepreneurial adaptation. Third, it introduces entrepreneurial digital sensemaking as a central cognitive mechanism linking environmental turbulence and strategic adaptation. Finally, the study highlights the critical role of organizational tolerance for uncertainty in shaping resilient entrepreneurial outcomes. Taken together, the findings demonstrate that startups operating within digitally turbulent environments do not merely survive through technological resources alone. Rather, resilience emerges through the interaction of entrepreneurial cognition, adaptive strategic capability, and supportive organizational climates. This integrated perspective significantly advances existing entrepreneurship literature and provides a stronger theoretical foundation for understanding venture resilience within emerging digital ecosystems.

Contributions

The present study contributes to the literature on entrepreneurship, strategic management, and digital entrepreneurship in several important ways. First, the study reconceptualizes venture adaptive resilience as a dynamic organizational outcome that emerges from continuous cognitive interpretation and strategic adaptation processes, rather than treating it as a static organizational characteristic. In doing so, the study advances existing resilience literature by providing a more process-oriented understanding of how startups respond to digitally turbulent environments. Second, the study contributes theoretically by integrating Dynamic Capability Theory, Sensemaking Theory, and Contingency Theory into a unified explanatory framework. This integrated perspective provides a more comprehensive explanation of entrepreneurial adaptation by simultaneously incorporating environmental turbulence, entrepreneurial cognition, strategic development, and contextual organizational conditions. The study therefore extends prior entrepreneurship research, which has often examined these dimensions in isolation. Third, the study introduces entrepreneurial digital sensemaking as a central cognitive mechanism linking digital environmental turbulence and strategic adaptive capability. By highlighting the role of entrepreneurial interpretation, environmental scanning, and

digital meaning construction, the study extends existing research on entrepreneurial cognition. It demonstrates how startups cognitively process digital disruption before translating it into adaptive strategic responses. Fourth, the findings identify entrepreneurial uncertainty tolerance climate as an important contextual boundary condition shaping the effectiveness of strategic adaptive capability in generating venture adaptive resilience. This contribution enriches contingency-based entrepreneurship literature by demonstrating that supportive organizational climates significantly influence adaptive outcomes under uncertainty. Finally, the study contributes empirically by providing evidence from Pakistan's emerging digital entrepreneurial ecosystem, a context that remains underexplored within entrepreneurship and strategic management research. By focusing on startups operating in environments of technological instability and institutional uncertainty, the study enhances the contextual relevance of entrepreneurial adaptation and resilience theories in emerging economies.

Practical Implications

The findings of the present study provide several important practical implications for entrepreneurs, startup founders, incubators, accelerators, and policymakers operating within digitally turbulent entrepreneurial environments. First, the results highlight the critical importance of entrepreneurial digital sensemaking and strategic adaptive capability in strengthening venture adaptive resilience. Startup leaders should therefore prioritize continuous environmental scanning, digital interpretation capabilities, and strategic flexibility to effectively respond to technological disruption, market volatility, and rapidly changing customer expectations. Developing mechanisms to interpret digital trends and emerging technological shifts on time may enable ventures to make more adaptive, resilient strategic decisions. Second, the findings emphasize the importance of cultivating organizational climates that tolerate uncertainty, experimentation, and adaptive risk-taking. Startups with greater tolerance for uncertainty are better positioned to convert adaptive strategic capabilities into resilient outcomes. Consequently, entrepreneurial leaders should encourage flexible decision-making structures, learning-oriented cultures, and openness to ambiguity to enhance organizational adaptability in digitally turbulent conditions. Third, startup incubators, accelerators, and entrepreneurial support institutions should design targeted capability-development programs emphasizing entrepreneurial digital sensemaking, adaptive strategic planning, uncertainty management, and resilience-building practices. Such initiatives may improve startups' abilities to navigate technological disruption and institutional instability more effectively. Finally, the study provides implications for policymakers seeking to strengthen entrepreneurial ecosystems within emerging economies. Policymakers should support digital entrepreneurship by improving technological infrastructure, digital accessibility, innovation support systems, and entrepreneurial development initiatives. Strengthening institutional support mechanisms and digital innovation policies can significantly enhance the resilience and long-term sustainability of startups operating in uncertain, rapidly evolving digital

environments.

Limitations and Future Research

Despite its important theoretical and practical contributions, the present study is subject to several limitations that should be acknowledged. First, the study employed a cross-sectional research design, which restricts the ability to establish definitive causal relationships among digital environmental turbulence, entrepreneurial digital sensemaking, strategic adaptive capability, entrepreneurial uncertainty tolerance climate, and venture adaptive resilience. Although the proposed relationships are theoretically grounded, future studies may adopt longitudinal designs to better capture the dynamic, evolving nature of entrepreneurial adaptation and resilience formation over time. Second, the study focused specifically on startups and technology-oriented SMEs operating within Pakistan's digital entrepreneurial ecosystem. While this context provides important insights into entrepreneurial adaptation under digitally turbulent conditions within emerging economies, the findings may have limited generalizability across different institutional, cultural, and economic environments. Future research may therefore replicate the proposed framework across developed economies, cross-country entrepreneurial ecosystems, or industry-specific settings to enhance external validity and comparative understanding. Third, although the present study incorporated entrepreneurial uncertainty tolerance climate as a contextual moderating mechanism, additional organizational and environmental contingencies may further influence venture adaptive resilience. Future studies may therefore integrate additional moderating or mediating variables such as entrepreneurial leadership, innovation culture, digital maturity, technological readiness, psychological resilience, or ecosystem support mechanisms to develop a more comprehensive understanding of entrepreneurial adaptation under digital turbulence.

CONCLUSION

The present study develops and empirically examines a moderated mediation framework that explains how digital environmental turbulence influences venture adaptive resilience through entrepreneurial digital sensemaking and strategic adaptive capability, while considering the moderating role of the entrepreneurial uncertainty tolerance climate. Grounded in Dynamic Capability Theory, the study demonstrates that entrepreneurial adaptation under digitally turbulent environments emerges through continuous environmental sensing, strategic flexibility, and organizational adaptation rather than through automatic responses to disruption. The findings reveal that digital environmental turbulence significantly enhances entrepreneurial digital sensemaking and strategic adaptive capability, while entrepreneurial digital sensemaking further strengthens adaptive strategic responses. In addition, strategic adaptive capability significantly improves venture adaptive resilience by enabling startups to sustain operational continuity and respond effectively to technological disruption. The study also confirms that entrepreneurial uncertainty tolerance climate strengthens the effectiveness of adaptive strategic

capability in generating resilient outcomes. Overall, the study provides a comprehensive, process-oriented explanation of resilience formation in emerging digital entrepreneurial ecosystems.

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