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The role of digital transformation and innovation in enhancing resilience and competitiveness of chinese logistics SMEs

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A B S T R A C T

This study explores the high-quality development of Chinese logistics small and medium enterprises (SMEs) by examining the impact of digital technology adoption, organizational resilience, exploratory innovation, and environmental uncertainty. The research investigates how digital transformation enhances operational efficiency, adaptability, and competitiveness while assessing the mediating role of exploratory innovation in linking technology adoption and resilience to enterprise success. Additionally, the study evaluates the moderating effect of environmental uncertainty on these relationships. A survey was conducted among 340 logistics professionals and SMEs operating within China's supply chain sector, focusing on their digital transformation efforts, resilience strategies, and innovation-driven business models. The hypotheses were tested using descriptive analysis in SPSS and structural equation modeling (SEM) in SmartPLS-4. The findings indicate that digital technology adoption and organizational resilience significantly enhance high-quality enterprise development, with exploratory innovation playing a crucial mediating role. Moreover, environmental uncertainty moderates the relationship between digital adoption and innovation, highlighting the need for adaptability in dynamic markets. This study contributes to the existing literature by integrating digital adoption, resilience, and innovation within a unified framework, particularly in the context of Chinese logistics SMEs. The results emphasize the importance of reducing digital adoption barriers, strengthening organizational resilience, and leveraging innovation to enhance long-term sustainability. Policymakers and industry stakeholders are encouraged to implement supportive trade policies, financial incentives, and technological investments to optimize the performance of Chinese logistics SMEs in an increasingly competitive environment.

1. Introduction

According to the World Economic Forum (WEC-Forum, 2024) report, digital transformation is a key driver of business sustainability and economic growth. Enterprises around the globe are integrating digital technologies to improve efficiency, growth, and competition. United Nations Industrial Development Organization (UNIDO, 2023), clarifies that the adoption of digital technologies allows companies to boost productivity, improve their decision making, and sustain growth over longer periods. The US and European Union as well as other developed economies are using digital technologies extensively in all business sectors. However, emerging economies like China are also undergoing a digital transformation where enterprises are investing in technology to remain competitive globally. The 14th Five-Year Plan (2021–2025) by the Chinese government highlights digital transformation as a crucial component of the country's economic development strategy. Hepburn et al. (2021) emphasize that the plan calls for faster digital adoption by enterprises to foster sustainable development, recognizing the pivotal role digital technologies

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play in driving economic growth and competitiveness in the global market. The logistics industry in China is rapidly changing due to the emergence of new digital technologies. As one of the primary drivers of economic activity, the logistics industry enables trade, integrates supply chains, and enhances industrial competitiveness (Zhao et al., 2023). While small and medium enterprises (SMEs) in China's logistics sector play an important role in facilitating trade and enhancing supply chain resilience, they still face challenges like rising operating costs, competition, and regulations (Ali et al., 2017). To boost Guangxi's fresh fruit industry, proposals focus on industry layout, logistics upgrades in key cities, and improved fruit transport quality (Pan, Panichakarn & Garin, 2024). The adoption of digital technologies can bring significant benefits but tends to affect growth through a mix of internal and external influences (Shahadat et al., 2023). While small and medium enterprises (SMEs) in China's logistics sector play an important role in facilitating trade and enhancing supply chain resilience, they still face challenges like rising operating costs, competition, and regulations (Ali et al., 2017). Most logistics SMEs are undergoing some form of digital transformation, yet these businesses seem unable to follow a clear developmental path because of limited funding, digital strategies, and volatile external conditions, as suggested by (Ngo et al., 2023). The adoption of digital technologies can bring significant benefits but tends to affect growth through a mix of internal and external influences (Pagani & Pardo, 2017). The logistics industry is undergoing drastic changes due to the fact that adopting digital technologies does not promise positive business returns (Ivanov et al., 2019). There also needs to be organizational resilience that can endure market disruptions, fluctuation, and risk (Gölgeci et al., 2020). Chinese logistics SMEs need to be structurally sound financially to remain in the market successfully. Such resilient firms are able to bounce back from crises, respond to their environment, and are able to sustain business operations (Su et al., 2022). However, the relationships among the adoption of digital technologies, organizational resilience, and high quality enterprise development still remains understudied. Also, the ability of a firm to put forth new ideas, new technologies, and new market opportunities is referred to as exploratory innovation and is imperative for digitally-enabled sustainable business success (Urbinati et al., 2020). Unfortunately, the existing literature is thin on the impact of exploratory innovation on the interrelation between resilient, technology adopting, and developing enterprises, yet the impact is great (Do et al., 2024).

This study centers on logistics SMEs in the New International Land-Sea Trade Corridor of China, which is undergoing accelerated industrial and digital transformation. The study regards such firms as those that have designed and are in the process of implementing digitalization of business processes (Miceli et al., 2021). Chinese logistics SMEs need to formulate appropriate strategies to optimally balance between digital sophistication and operational efficiency (Zheng et al., 2024). The study examines their innovation challenges, resilient capabilities, and attempts to offer practical recommendations on how SMEs can thrive in the face of uncertainty. Unfortunately, the previous research which concentrates on any of the two extremes of digital adoption or resilience, this study integrates both to find out how they affect the success of an enterprise. It adds exploratory innovation and a level of environmental uncertainty Parnell et al. (2015), so that competitive factors for Chinese logistics SMEs can be analyzed at international and domestic levels. This study offers significant contributions to the academic literature by unbundling the constructs of digital adoption and organizational resilience, integrating them into a unified framework to enhance the understanding of enterprise development. Additionally, it introduces exploratory innovation as a mediating factor, shedding light on how firms leverage digital transformation to achieve business success, thereby emphasizing the role of innovation in driving digital strategies. A unique aspect of this research is its nontraditional modeling approach, which includes environmental uncertainty as a moderating variable, highlighting how external market conditions influence the effectiveness of digital strategies. Li et al. (2018) highlight that this study explores one of the least researched areas of digital transformation, specifically within the context of a Chinese logistics SME. By focusing on this underexplored sector, the research fills a gap in the literature, addressing the limited studies on digital transformation in SMEs. This study also contributes to high-quality enterprise development literature by combining digital adoption, resilience, and innovation into a comprehensive business model framework (Kumar et al., 2024), which contrasts with prior works that treat these elements in isolation. The introduction of exploratory innovation as a critical mediator reshapes enterprise development strategies, emphasizing innovation as an essential driver of growth. Moreover, the study incorporates insights from Chuang and Huang (2018), offering practical recommendations for enterprises seeking to improve competitiveness and sustainability. By considering both internal factors such as digital adoption, resilience, and innovation, and external factors like environmental uncertainty, this research provides a comprehensive understanding of the mechanisms behind high-quality enterprise development (Zhang et al., 2024).Overall, the study offers new insights into how firms can navigate the complexities of digital transformation in an uncertain market, providing a more nuanced approach to enterprise development in the modern business landscape.

2. Theoretical Foundation and Hypothesis development

2.1 Dynamic Capabilities Theory and Resource-Based View

The Dynamic Capabilities Theory explains organizational resilience, technology adoption, and innovation. It argues that businesses must adapt to new technological and market changes in real-time in order to remain competitive (Arranz et al., 2020; Veiga et al., 2024). According to DCT, companies that undergo a digital transformation use a more relaxed, innovative-centered business policy which enhances efficiency, agility, and competitiveness in the long term (de Paula Pereira et al., 2024). As for Chinese logistics SMEs, utilizing digital technologies is crucial in reengineering business processes, supply chain optimization, and

improving disruption-related resilience (Sun et al., 2024). Choi et al. (2022) notes that combining digital technologies, AI, the Internet of Things, and cloud-based logistics, through proactive innovation leads to the formulation of new business concepts and products, which fosters the advancement of the enterprises. The Resource-Based View (RBV) complements the DCT by offering further insights as to how Proactive Innovation, Environmental Uncertainty, and Enterprise High Quality Development is achieved through valuable, unique, costly to imitate, and resources (Hafiz et al., 2021). The flexible supply chain management, as well as the digital technological infrastructure, is regarded by Li et al. (2023) regards human resources, technological advances, and infrastructure as the key competitive resources in China's logistics industry. Wang and Sun (2024) explain that exploratory innovation is typically associated with an internal resource change that has growth potential and a low external risk exposure. The competitive benefits of resilient logistics small and medium enterprises (SMEs) rest on fully digitalized policies, and the competitive advantages of resilient logistics SMEs are dependent on comprehensive digitalized strategies (Kumar et al. ,2024). Hence, the integration of DCT and RBV explains the other side in which digital transformation, resilience, and innovation interact to foster superior development in Chinese logistics SMEs within dynamic markets.

2.2 Hypothesis Development

2.2.1 Digital Technology Adoption and High-Quality Development of Enterprises

The application of digital technology aids in increasing process efficiency and operational integration, leading to better development and competitiveness in firms. Current research shows that firms using modern digitized systems, automation, and data driven decision making tend to have better operational output, productivity, and sustainability over time (Bousdekis et al., 2021). Other theories regarding new technology adoption are underpinned by Dynamic Capabilities Theory which suggests the reconfiguration of business resources, improvement of business strategy processes, and responsiveness to previously hostile business conditions (Teece et al., 1997). The Function of Political Leaders in the Allocation of Resources and Strategic Planning for Achieving Growth and Development Economically (Iqbal, Ummara, et al., 2024). The success of a company's digital transformation and business agility is directed by project planning and risk management (Fazly et al., 2024). Meng et al. (2023) explained the effectiveness of processes in logistics companies as a result of their digital transformation and the business agility for sustainable development. Other studies found that businesses focusing on artificial intelligence (AI), internet of things (IoT), and cloud services have better cost management, improved logistics management, and effective risk management, which supports the development of the enterprise (Alsudani et al., 2023). Motivation strategies and operational emphasis is placed on transforming the project performance of the business in aid of the digital and market expansion (Fareed et al., 2024). Furthermore, digital transformation enhances business expansion into new markets, supply chain integration, and competition in saturated industries where market fluctuations make it challenging to maintain stability over time.

H_1: *Digital Technology Adoption is positively associated with High-Quality Development of Enterprises.*

2.2.2 Organizational Resilience and High-Quality Development of Enterprises

The development of Chinese logistics SMEs depends greatly on organizational resilience, which enables the firms to encounter disturbances, adapt to market volatility, and continue to grow over extended periods. The integration of organizational resilience and environmental management practices greatly improves the performance and sustainability of SMEs over time(Bresciani et al., 2023). As Dovbischuk (2022) observed, resilient organizations are capable of managing and adapting to ever emerging economic, technological, and operational obstacles present in China's logistics industry by utilizing strong risk management, adaptive capabilities, and response systems. Kashif et al. (2020) noted that by utilizing the on-job training, training design, and training delivery systems, resilient organizations improve performance while facing challenges. The Dynamic Capabilities Theory suggests that firms undergo resource reconfiguration and market changes, incorporating new risk management and safety climate strategies in order to maximize the success of project planning (Iqbal, Nawaz, Ali, et al., 2024). Such claims are supported by The Dynamic Capabilities Theory because it posits that firms with resilient structures tend to reconfigure resources, adjust to market changes, and remain competitive within the firm's spots (Kurtz & Varvakis, 2016). This type of resilience is equally important among Chinese logistics SMEs for coping with alterations in trade policies, supply chain challenges, and changes in digital logistics (Gupta et al., 2022). Furthermore, studies reveal that enterprises strategically positioned with strong leadership, agility, and proactive response strategies tend to outperform, achieve higher customer satisfaction, and succeed over extended periods, which enhances competition in the rapidly growing logistics industry of China (Pfaff, 2023).

H_2: *Organizational resilience is positively associated with High-Quality Development of Enterprises.*

2.2.3 The mediating role of Exploratory Innovation between Digital Technology Adoption and High-Quality Development of Enterprises

In relation to Chinese logistics SMEs, exploratory innovations address new digital integration gaps along with higher-order firm development. In times of external unpredictability, the Innovative, agile, and digitally transformed approach increases the productivity of Chinese SMEs (Panichakarn et al., 2024). With reference to Lai et al. (2006), it is evident that businesses undergoing a digital transformation incorporate steps to facilitate incremental innovation and knowledge retention that assures them a competitive position in the rapidly evolving logistics environment in China. Exploratory innovative SMEs employ digital technologies, for example, AI-enabled logistics, automation, and cloud computing, to develop new business solutions, enhance resource utilization, and expand market share (Iqbal, Nawaz, Hamza, et al., 2024). The integration of these new technologies brought about positive changes in the automation innovation of logistics, particularly with the integration of AI and IoT technologies (Ding et al., 2021). The adoption of these new strategies and modern innovations. Moreover, adoption of digital technologies leads to innovation-driven strategies fostering business sustainability and high-quality enterprise development among Chinese logistics SMEs.

H_3: *Exploratory innovation plays a mediating role in the relationships between Digital Technology Adoption and the High-Quality Development of Enterprises.*

2.2.4 The mediating role of Exploratory Innovation between Organizational Resilience and High-Quality Development of Enterprises

The adoption of new business models, adaptive strategies, and innovative solutions is made possible by firms investing in exploratory innovation, and this is central to turning organizational resilience into a high quality enterprise development (Carayannis et al., 2014). Resilient organizations are more prepared to deal with ambiguity, putting additional funds to R&D, and instituting change that is revolutionary, which helps to guarantee sustainability in the long term (Lv et al., 2018). Under the Dynamic Capabilities Theory, resilient businesses reallocate resources and engage in constant innovation in order to stay competitive in the hostile world of business (Liu et al., 2024). According to the Dynamic Capabilities Theory, adaptive firms fuel green supply chain management through resource reconfiguration and continuous innovation (Muhammad Javid et al., 2024). Proactive encouraging exploratory innovation generates technological, market, and operational phi adeptness advancements by proactively resilient organizations. These attributes of agility paired with a great innovation culture will make the organization more likely to achieve high quality enterprise development and will ensure sustainable growth through volatile markets (Gölgeci et al., 2020). The observations are indicative of the importance of an agility-centered innovative approach for the success of businesses operating in highly competitive environments striving for sustainability.

H_4: *Exploratory innovation plays a mediating role in the relationships between Organizational Resilience and the High-Quality Development of Enterprises.*

2.2.5 Environmental Uncertainty Moderates the Relationship between Digital Technology Adoption and Exploratory Innovation

Environmental uncertainty is a critical factor affecting how enterprises exploit and digitally transform to implement exploratory innovation, particularly in Chinese logistics small and medium enterprises (Li et al., 2024). Climate change affects how companies innovate and transform digitally which, in turn, affects the role of inclusive leadership on the success of the project (Nawaz & Qayyum, 2022). When market circumstances are volatile, firms need to constantly be flexible and creative in responding to advancing technologies as well as competitive challenges (Sanchez, 1997). The Resource-Based View (RBV) states that firms with sufficient and strong technological stocks are able to use digital resources to boost exploratory innovation (Coates & McDermott, 2002). Abdelkafi and Pero (2018) argue that firms implementing digital technologies seem to be more active in exploratory innovation regarding the creation of new logistics services and supply chain enhancements. However, firms in more stable environments are likely to focus more on incremental changes. Green innovation and organizational learning within a firm result from the proactive adoption of technologies aimed at succeeding from the environmental uncertainties perspective (Iqbal, Nawaz, Aslam, et al., 2024). Moreover, Hashem et al. (2024) argue that uncertainties in the environment compel firms to be more proactive in technology adoption which leads to accelerated digital transformation and the adoption of innovations for competitive advantage over time.

H_5: *Environmental Uncertainty significantly moderates the relationship between Digital Technology adoption and exploratory innovation.*

2.2.6 Environmental Uncertainty Moderates the Relationship between Organizational Resilience and Exploratory Innovation

Environmental uncertainty contributes significantly to the organizational resilience and exploratory innovation of Chinese logistics SMEs (Mehmood et al., 2024). Damanpour and Gopalakrishnan (1998) posit that the companies located within unpredictable environments need to undergo constant change, experimentation, and implementation of new ideas. RBV contends that innovative and adaptable firms have higher chances of leveraging their resources for innovation, but this is a function of market instability (Do et al., 2022). Osiyevskyy and Dewald (2015) states that firms engage in exploratory innovation through novel business strategy implementation and investment into digital changes with the hope to derive profits during periods of uncertainty. Conversely, stable environments may cause firms to concentrate on incremental changes to the existing products or services. Ding et al. (2025) also argues that uncertainty heightens the demand for innovation which renders it crucial for Chinese logistics SMEs to adopt agility, smart logistics, and adaptive strategies to deal with trade shocks for enduring sustainable growth.

H_6: *Environmental Uncertainty significantly moderates the relationship between Organizational Resilience and exploratory innovation.*

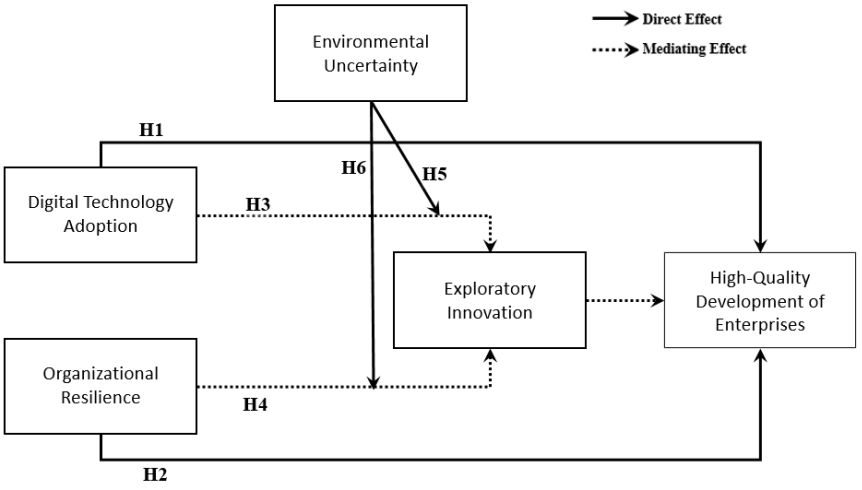

Fig. 1. Research Framework

3. Methodology

3.1 Research Design, Sampling & Data Collection Procedures

In this study, a cross-sectional survey was conducted among logistics managers and supply chain coordinators working in Chinese logistics SMEs (Hunziker & Blankenagel, 2024). Respondents were chosen through an arbitrary sampling method using the filter of having a minimum of five years of experience dealing with the digitization of logistics activities and meeting legal obligations for braided reliability. Out of 1200 survey invitations that were sent out to industry specialists, 452 completed the questionnaires. However, only 340 cleaned and validated their data, which then enabled them to undergo the subsequent analysis. Data collection lasted six weeks using an online survey platform, resulting in a 27.0% response rate (Kurzhals, 2021). These were useful to collect the feedback in China's logistics SME sector on the role of the adoption of digital technologies, organizational resilience, exploratory innovation, and environmental uncertainty and enterprise development.

3.2 Data Analysis Technique and Ethical Considerations

We utilized IBM SPSS Statistics, which calculated central measures and variation in the data, specifically within the boundaries of hypothesis testing, and SEM with Smart PLS 4 for more intricate inter variable relationships (Hair Jr et al., 2021). Prior to the commencement of the data-gathering tasks, each individual was provided relevant information concerning the intent of the study along with a consent form. Steps that were followed to privacy and confidentiality included file encryption and data anonymization as part of the ethical considerations of research conduct (Iversen et al., 2006).

3.3 Measuring Instruments

The measuring scale was adapted and digital technology adoption was assessed Yang et al. (2021) with integration of digital technologies into logistics and supply chain operations. Organizational Resilience used a six items scale to measure SMEs' capacity to adapt to Hillmann and Guenther (2021) supply chain disruptions. Exploratory Innovation was measured and adapted (Jansen et al., 2006) through a seven-item scale capturing firms' attempts towards implementing innovative logistics practices. Environmental Uncertainty was assessed and adapted Jansen et al. (2006) with a seven-item scale regarding the changes of the market and government policies related to the China supply chain. Lastly, High-Quality Enterprise Development was measured and adapted Luo et al. (2023) using a seven-item scale, ensuring sustainable growth and operational excellence within logistics SMEs. In this study, the survey questionnaire included a seven Likert scale ranging from 1 = Totally disagree; 2= disagree; 3= Somewhat disagree; 4 = Neutral; 5 = Somewhat agree; 6 = Agree; and 7 = Strongly Agree.

3.4 Common Method Bias

In this study, we will employ certain procedural and statistical methods to minimize the impact of Common Method Bias (CMB). First step will include ensuring that all items in the questionnaire are as straightforward and direct as possible in order to minimize participant misunderstanding. Also, to improve reliability and reduce response pattern biases, reverse-coded items will be added and spaced throughout the questionnaire. Statistically, I will utilize Harman's single-factor test and the partial correlation method, as Kock, (2015), recommends, to account for CMB effects. These strategies will guarantee that the results of the study will be accurate and unbiased by systematic measurement errors.

4. Analysis and Results

A comprehensive quantitative analysis employs an investigation to explore the relationships shown in Fig. 1 of the research framework by statistical and correlation analysis (Table 1) and emphasizing data-driven rigor.

Table 1
Descriptive Statistics and Correlations for the Variables

					Correlations								
	Mean	SD	Kurtosis (-7 to +7)	Skewness (-2 to +2)	1	2	3	4	5	6	7	8	9
1.Gender	1.14	0.26	6.312	1.832	1								
2.Age Group	1.23	0.62	1.121	-1.612	0.117	1							
3.Education	2.23	0.67	2.523	1.126	0.022	0.10	1						
4.Work Experience	2.16	0.57	5.898	1.941	0.042	0.38	0.02	1					
5.Digital Technology Adop-	4.67	0.47	-2.725	-1.155	0.126	0.26	0.11	0.02	1				
6.Organizational Resilience	4.12	0.39	3.199	-1.919	0.157	0.16	0.04	0.10	0.67	1			
7.Environmental Uncertainty	4.09	0.48	-4.188	1.051	0.022	0.20	0.02	0.10	0.58	0.64	1		
8.Exploratory Innovation	3.13	0.50	3.197	1.892	0.013	0.53	0.01	0.06	0.60	0.55	0.50	1	
9.High-Quality development	2.86	0.56	-4.985	-1.625	0.087	0.19	0.01	0.14	0.54	0.62	0.42	0.48	1

Note: Sample size (n)= 340; α: Cronbach's alpha; SD: Standard deviation; AVE: Average Variance Extracted; CR: Composite Reliability.

1Gender: Male (Total=289, 85%); Female (Total=51, 15%)

2 Age Group: Below 25 Y (Total=26, 7.5%); 26Y-35Y (Total=264, 77.5%); 36Y-50Y (Total=39, 11.4%); Above 50Y (Total=12, 3.6%)

3Education: Intermediate (Total=79, 23.1%); Bachelor (Total=236, 69.3%); Master/Ph.D. (Total=26, 7.6%)

4Work Experience: Less than 6Y (Total=70, 20.5%); 7Y-12Y (Total=169, 49.7%); 13Y-18Y (Total=56, 16.4%); Above 18Y (Total=46, 13.4%)

4.1 Measurement Model

Before conducting hypothesis testing, we ensured measurement accuracy by first assessing the reliability and validity of the constructs. All items achieved the necessary criteria, meeting construct reliability and validity, AVE > 0.5, Cronbach's alpha & Rho-C > 0.7 Bonett and Wright (2015), which is illustrated in Table 2 and Figure 2. Strong internal consistency is indicated by the range of Cronbach's alpha values of 0.802 to 0.855. In addition, the range of composite reliability (CR) and rho-C values of 0.862 to 0.912 confirmed the reliability of the constructs. The AVE values ranging from 0.563 to 0.598 also surpassed the benchmark value of 0.5, illustrating that the constructs were able to adequately capture the variance in their items. As well, all factor loadings greater than 0.7 proved a strong relationship exists between the items and their constructs (Hair Jr et al., 2021). VIF values were calculated as a means to check for multicollinearity, and all values were below the threshold of 3, validating the absence of

multicollinearity issues (Fornell & Bookstein, 1982). This finding confirms the boundaries of the theoretical framework and prepares the groundwork for the following structural model analysis.

Table 2
Construct robustness of measurement model

Constructs	Items	Factor Loadings	VIF	Cronbach's alpha	CR (rho_c)	AVE
Digital Technology Adoption	DTA1	0.779	2.571	0.855	0.893	0.582
	DTA2	0.875	2.571			
	DTA3	0.721	1.532			
	DTA4	0.741	2.197			
	DTA5	0.729	1.797			
	DTA6	0.72	1.617			
Organizational Resilience	OR1	0.754	2.062	0.834	0.871	0.578
	OR2	0.772	2.164			
	OR3	0.803	2.458			
	OR4	0.793	2.532			
	OR5	0.721	1.954			
	OR6	0.715	1.536			
Exploratory Innovation	EI1	0.724	1.606	0.802	0.862	0.557
	EI2	0.797	2.554			
	EI3	0.715	2.035			
	EI4	0.732	1.636			
	EI5	0.76	1.649			
Environmental Uncertainty	EU1	0.773	1.895	0.888	0.912	0.598
	EU2	0.725	1.660			
	EU3	0.783	2.265			
	EU4	0.784	2.310			
	EU5	0.817	2.320			
	EU6	0.783	2.312			
	EU7	0.743	2.048			
High Quality Development of Enterprises	HQDE1	0.767	1.799	0.845	0.885	0.563
	HQDE2	0.749	1.833			
	HQDE3	0.797	1.945			
	HQDE4	0.734	1.692			
	HQDE5	0.703	1.560			
	HQDE6	0.75	1.819			

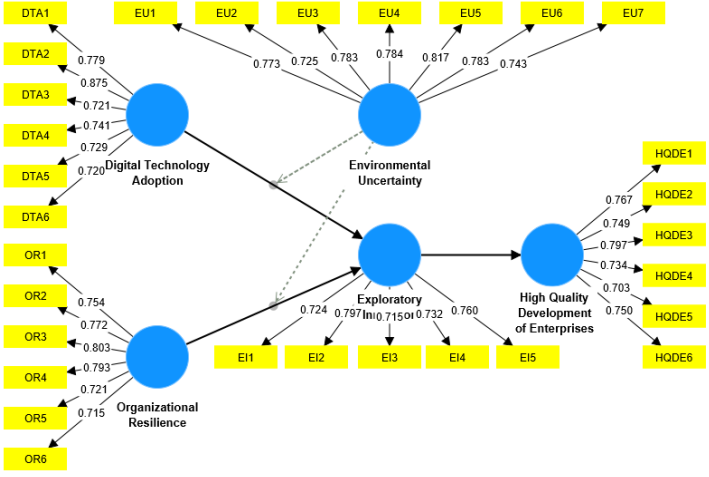

Fig. 2. Confirmatory factor analysis
Source: Author's constructed

4.2 Discriminant Validity

To test the discriminant validity, we used the Heterotrait-Monotrait (HTMT) ratio and the guidelines from Henseler et al. (2015), As stated in Table 3, all of the HTMT values are below 0.85, which means that discriminant validity has been achieved. Also, the Fornell-Larcker criterion confirmed that the HTMT values were below 0.85, which enhances the validity of the model that has been proposed. These results affirm that the constructs are well-defined, conceptually distinct, and part of a robust measurement

model**.** The findings ensure that there is no significant overlap between constructs, confirming that each variable uniquely contributes to the model's overall explanatory power.

Table 3
Discriminant Validity

Variables	DTA	EI	EUG	HQDE	OR
Discriminant Validity (HTMT) ratio					
DTA					
EI	0.848				
EU	0.821	0.821			
HQDE	0.750	0.825	0.801		
OR	0.792	0.810	0.735	0.764	
Fornell-Larcker criterion					
DTA	0.763				
EI	0.696	0.746			
EU	0.724	0.75	0.773		
HQDE	0.648	0.731	0.812	0.751	
OR	0.681	0.69	0.649	0.758	0.76

Note: DTA= Digital Technology Adoption, EI= Exploratory Innovation, EU= Environmental Uncertainty, HQDE=High-Quality Development of Enterprises, OR= Organizational Resilience.

4.3 Model Fitness

We assessed model fitness using chi-square, Goodness of Fit Index (GFI), Adjusted GFI (AGFI), Comparative Fit Index (CFI), and RMSEA. The results show $p < 0.05$ (0.000), Chi-square/df = 2.73 (acceptable), and RMSEA = 0.069 (<0.08), confirming a strong model fit. GFI (0.74), AGFI (0.76), SRMR (0.059), and CFI (0.73) further support model robustness (Goretzko et al., 2024).

4.4 Hypotheses Testing

Using PLS-SEM, we examined the structural model relationships among the study's constructs (Kock, 2016). Table 4 provides a detailed analysis of the hypotheses, assessing statistical significance through path coefficients (β), standard deviation (SD), t-values, p-values, and confidence intervals (CI). The findings validate all proposed hypotheses, highlighting the critical role of digital technology adoption, organizational resilience, exploratory innovation, and environmental uncertainty in driving high-quality enterprise development, particularly within Chinese logistics SMEs. H1 confirms a strong positive relationship between Digital Technology Adoption and High-Quality Enterprise Development (β=0.506, t=10.54, p=0.000), emphasizing that Chinese logistics SMEs investing in AI-driven automation, cloud-based logistics, and digital platforms experience enhanced operational performance and market agility. H2 supports the notion that Organizational Resilience strengthens High-Quality Development (β=0.441, t=7.875, p=0.000), suggesting that resilient firms better navigate supply chain disruptions, market volatility, and regulatory changes. The study further validates the mediating role of Exploratory Innovation (H3 and H4), showing that SMEs leveraging digital adoption and resilience through innovation-driven strategies achieve superior long-term growth (β=0.519, t=12.36, p=0.000) and (β=0.411, t=7.755, p=0.000). Additionally, H5 and H6 confirm the moderating effect of Environmental Uncertainty, indicating that firms operating in unstable market conditions must enhance adaptability, digital transformation, and innovation capacity to remain competitive (β=0.389, t=10.24, p=0.000) and (β=0.296, t=8.970, p=0.000). These results underscore the importance of digital transformation, organizational resilience, and innovation-driven adaptability in ensuring sustainable growth and long-term competitiveness of Chinese logistics SMEs.

Table 4
Hypothesis Result

						Confidence Interval		
Hypothesis	**Relationship**	**β**	**STDEV**	**t**	**p**	**2.50%**	**97.50%**	**Status**
H1	DTA→HQDE	0.506	0.048	10.54	0	0.412	0.6	Accepted
H2	OR→HQDE	0.441	0.056	7.875	0	0.331	0.551	Accepted
H3	DTA→EI→HQDE	0.519	0.042	12.36	0	0.437	0.601	Accepted
H4	OR→EI→HQDE	0.411	0.053	7.755	0	0.307	0.515	Accepted
H5	EU* DTA→EI	0.389	0.038	10.24	0	0.315	0.463	Accepted
H6	EU* OR→EI	0.296	0.033	8.97	0	0.231	0.361	Accepted

Note: DTA= Digital Technology Adoption, EI= Exploratory Innovation, EU= Environmental Uncertainty, HQDE=High-Quality Development of Enterprises, OR= Organizational Resilience

5. Discussion

This study aimed to analyze the impact that the adoption of digital technology, organizational resilience, exploratory innovation, and environmental uncertainty have on the high quality development of Chinese SMEs in the logistics industry. The results

confirm that the adoption of digital technologies positively improves the development of enterprises because those that have advanced digital solutions adopted have greater operational efficiency, agility, and competitiveness in the market (Kő et al., 2022). The data confirms H1 as there exists a strong positive relationship on the impact of digital adoption on enterprise development (β=0.506, t=10.54, p=0.000). This means that many Chinese logistics SMEs, through the effective adoption of automation, cloud computing, and data analytics, are able to optimize decisions, logistics operations, and market positioning (Lai et al., 2018). Such findings illustrate the Dynamic Capabilities Theory which states that organizations must consistently transform and utilize technology for sustainable growth over time (Shen et al., 2022). Besides, the research validates H2 and affirms that organizational resilience has a positive effect on the quality of enterprise development (β=0.441, t=7.875, p=0.000). Enterprises that are resilient put into place strong adaptive management leadership and sustainable business practices, which allow them to endure economic variances, supply chain interferences, and regulatory ambiguity, which is pertinent to Chinese logistics SMEs (Ramezani & Camarinha-Matos, 2020). These findings are in agreement with earlier research results that pointed out highly resilient organizations are more likely to result in innovations, sustained profitability, as well as strategic flexibility (Ortiz-de-Mandojana & Bansal, 2016). The Dynamic Capabilities Theory sustains this assertion, offering that corporations that adjust dynamically to changes in the environment allow their competitors to hold onto the edge (Li & Liu, 2014). Moreover, the findings validate the mediating effect of exploratory innovation on the improvement of enterprise development. H3 validates the hypothesis that exploratory innovation has a positive mediating effect on the relationship between digital adoption and enterprise growth (β=0.519, t=12.36, p=0.000). Chinese logistics SMEs investing in smart logistics with real-time monitoring and automated digital warehouses tend to sustain superior developmental achievement (Tran-Dang et al., 2025). As noted by Elia et al. ,2021 the Resource Based View (RBV) explains how a firm's internal capabilities like digital skills and innovativeness help to leverage specific technological resources to gain advantage over other competitors.

Likewise, H4 addresses the effect of organizational resilience on enterprise development with the mediating effect of exploratory innovation (β=0.411, t=7.755, p=0.000). This means that more resilient firms are willing to innovate and new logistics model changes and strategic changes are necessary in response to the rapid evolution of e-commerce and logistics in China (Zhang, 2025). Resilient logistics SMEs, by embedding continuous innovation in their corporate culture, enhance their technological and sustainable competencies in order to compete in global supply chains (Mishra & Singh, 2023). The analysis emphasizes how uncertainty factors and technological innovations affect the firm's operations. H5 posits that the use of digital technologies and exploratory innovation are associated with an environmental uncertainty that moderates their relationship (β=0.389, t=10.24, p=0.001). This means that uncertainties related to the shifting policies, supply chain limitations, and global market activities are likely to contribute more towards the tendencies of Chinese logistics SMEs to embrace new digital technologies and novel business practices (Saberi et al., 2019). However, it seems that stable environments encourage firms to implement incremental rather than radical changes (Meyer et al., 1990). These findings illustrate relatively greater agility to respond in terms of adaptation by logistics SMEs within more turbulent environments who need to undergo a digital transformation (Saeedikiya et al., 2024). In the H6 testing, we found that environmental uncertainty moderated exploratory innovation and organizational resilience (β=0.296, t=8.970, p=0.001). In other words, during unfavorable market conditions, resilient firms in the Chinese logistics industry are more likely to undergo digital innovations, automate supply chain processes, and implement agile delivery systems (Irfan et al., 2022). This supports the Resource-Based View theory which argues that stronger internal resources within an organization enable its ability to withstand external challenges and therefore strategically position (Truyens et al., 2014).

The findings of this study validate the proposed research framework and accompany the effects of adopting digital technologies with organizational resilience, exploratory innovation, and environmental uncertainty in the development of Chinese logistics SMEs. The interplay between technological changes, resilience-oriented organizational learning, and innovation suggests that business agility strategies and adaptive approaches for sustaining growth in the Chinese logistics industry. Concerning the fast-evolving logistics landscape in China, there are gaps related to inter-industry competition, government policy impacts, and the effects of emerging technologies such as block chain, IoT, and AI on logistics optimization and attainment of strategic business objectives that need further examination.

5.1 Conclusion

This research analyzes the effects of emerging technologies, the flexible nature of the organizational structure, innovation, and environmental uncertainty on the growth of small and medium-sized Chinese logistics enterprises. The findings validate that the processes of digitization lead to increased efficiency in business operations, enhanced agility, improved competitiveness in the market, and, in the long term, growth in China's logistics sector. By Dynamic Capabilities Theory, companies that strategically position themselves ahead of competition by automating, decision-making through AI, and employing smart logistics technologies tend to outperform their competitors. Resilience is an imperative factor within the organization's strategies aimed at external shocks like trade policy changes or supply chain uncertainty. Such firms have a higher degree of proactivity towards identifying new growth markets. Exploratory innovation justifies the relationship between the adoption of digital technologies, organizational resilience, efficiency in operational costs, and effectiveness in service delivery. The interdependencies rely on the uncertainty of

the external environment, which makes it clear the need to be complex and advanced technologically in highly competitive markets. Chinese logistics SMEs must foster a culture of continuous innovation and resiliency, digitization to cope with external uncertainties. Further research should address China's logistics sustainability and competitiveness through external sector specific digital situations and changes.

5.2 Theoretical Implications

This study on Chinese logistics SMEs utilizes organizational resilience, adaptive innovation, environmental uncertainty, and digital technology adoption to advance enterprise development. It integrates Dynamic capabilities theory with the Resource Based View (RBV) to create a comprehensive framework for analyzing competitiveness in the era of digital transformation, innovation, and resilience. In this research, DCT was advanced by illustrating how adopting digital tools and being resilient encourages proactive innovative behaviors that support the enterprise's growth under adverse conditions. It emphasizes the need for constant resource reconfiguration by Chinese logistics SMEs to adapt to shifting supply chain dynamics, trade boundaries, and global competition. Furthermore, their work contributes to RBV by demonstrating that innovation and strategic agility enabled firms to sustain their performance through technology spending. Exploratory innovation as an important mediator that enables the employment of smart logistics, digital platforms, and AI for both efficiency and differentiation activities. These effects are counseled by uncertainty of the environment, and therefore, the need for robust digital and innovation strategies to maintain constancy is further amplified. This research contributes to the ongoing discussion regarding China's logistics sector SMEs' transformation in the context of globalization, regulatory changes, and technological innovations from the perspective of strategic and enterprise digital transformation management and sustainability.

5.3 Practical Implication

This research offers insights for the SMEs, policymakers and industry executives of the Chinese logistics sector that seek to improve high quality enterprise growth through digital transformation, resilience and innovation strategies. To make operations more productive, competitive supply chains availability, and business agility preserved, digital adoption is fundamental. SMEs should automate their business processes, AI-based logistics management, and cloud-based systems must be used to enhance efficiency and cut expenses. There is also a great need for fostering organizational resilience to deal with uncertainties such as supply chain disruptions, changes in trade policies, and market volatility which requires creating risk mitigation processes, improving supply chain monitoring, and incorporating flexibility in business models. In addition, these firms can environmentally friendly grow by adopting smart warehousing, improving last mile delivery, and novel logistics systems through exploration-oriented innovation. In terms of policy, the Chinese authorities ought to aid SMEs using digital encouragement, better facilities, and less red tape. Better regulation on trade and cross-border trade may assist in global expansion. In light of the fast-changing nature of the Chinese logistics industry, SMEs that proactively embrace digital transformation, innovation, and resilience will enhance their competitiveness, customer service, and sustainable growth of the business in the long-run.

5.4 Limitations and Future Research Directions

This study's limitations suggest directions for further research. As it looks at the adoption of digital technology, organizational resilience, exploratory innovation, and environmental uncertainty in Chinese logistics SMEs, it does not pay much attention to macroeconomic factors, sustainability issues, and even geopolitical considerations that may also play a role in enterprise development. Future research will have to assess the impacts of global trade disruptions and regulatory changes, as well as supply chain sustainability efforts within China's growing business environment. Moreover, the use of self-administered survey data can be subjective and lead to biases which compromise objectivity. Other relevant data, including reports from the industry and those obtained over prolonged periods of time, would add value to the analysis. The focus of this study was primarily on Chinese logistics SMEs which restricts its generalizability to other regions, although other studies should determine how logistics SMEs in Southeast Asia, Europe and Latin America integrate digital technologies under diverse economic and policy environments. Another important gap under the literature is formulated by the sustainability strategies, including but not limited to, competitive transportation and green warehousing. Studies looking at the impact of trade policy and the digital transformation, the adoption of innovation over time, as well as other qualitative approaches, like collecting data through expert interviews, could shed light on the obstacles and drivers of digital transformation of logistics SMEs of different regions.

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