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Research paper

Financial Performance of Innovation Investment in Specialized SMEs Under A Digital Business Environment: A Comparative Analysis of China and Thailand (2019-2024)

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Abstract

This study investigates the financial performance implications of innovation investment in specialized small and medium enterprises (SMEs) operating within digital business environments, comparing China and Thailand from 2019-2024. Using a mixed-methods approach, this research employs Partial Least Squares Structural Equation Modeling (PLS-SEM) and Data Envelopment Analysis (DEA) to analyze primary survey data from 284 specialized SMEs (184 Chinese, 100 Thai) and secondary financial data covering the pre- and post-digital trans-formation periods. The Sustainable Digital Transformation (SDT) framework is integrated with the Technology-Organization-Environment (TOE) model to examine innovation investment impacts. Results reveal significant positive relationships between innovation investment and financial performance in both countries, with Chinese SMEs demonstrating 23% higher ROI from digital innovation investments compared to Thai counterparts. Digital transformation mediates 68% of the innovation investment-performance relationship in China versus 45% in Thailand. Manufacturing SMEs in both countries outperform service-sector SMEs by 31% in innovation-driven financial performance. The study is limited to two countries and may not generalize to other emerging economies. Cultural and institutional differences between China and Thailand provide valuable insights but limit broader applicability. Practical implications: Before applying innovation strategies, SME managers need to invest in digital infrastructure. Government-pushed policies that encourage digital transformation yield 2.3× more productive innovation investment. It is the first comprehensive comparative study examining the financial performance of innovation investment in China and Thailand's specialized SMEs for the critical digital transformation period of 2019-2024, providing theoretical and practical implications to emerging market SMEs.

Keywords: *Innovation Investment; SME Financial Performance; Digital Transformation; China; Thailand; Comparative Analysis.*

1. Introduction

The digital revolution has profoundly changed the business environment for small and medium-sized enterprises (SMEs), creating historic opportunities and challenges to innovation investment strategies. Niche SMEs, as a set of companies that specialize in specific market niches and have focused capabilities, are subject to specific pressure for innovation while maintaining fiscal sustainability across rapidly evolving digital contexts (Liu & Suzuki, 2024; Chen et al., 2016). The contact point between innovation expenditure and digitalization is now a major factor influencing the financial performance of SMEs, especially when it comes to those pertaining to emerging economies and which are not distributed evenly in digital adoption rates.

The two emerging markets related to the study of the phenomenon are China and Thailand in contrast but association. According to EUSME (2023), China has about 52 million SMEs generating 60% of GDP and 80% of employment, amounting to 50% of the nation's tax revenue. About 60% of Chinese SME specialists have embraced R&D plans (Hang, 2024). In Thailand, there are 3.2 million SMEs accounting for 90% of businesses in the country (Krisanaraj, 2025). According to Marketing and Communications (2025), Thailand SMEs have achieved 100% online presence during the era of digital acceleration, surpassing the worldwide average of 95%. While economically significant, few studies have taken into consideration how innovation investments find their expression in financial performance in digital business settings in these two strategic Asian markets.

The urgency of this question has been amplified in the wake of the 2019-2024 period, which saw rapid digital evolution owing to worldwide interruptions and technological development. Chinese SMEs allocated an average of 7.5% of revenue to digital transformation initiatives, while Thai SMEs demonstrated 77% adoption rates for new IT solutions compared to 39% globally (Liu et al., 2023; Chen et al., 2019). However, the financial performance implications of these innovation investments remain under-researched, particularly in comparative contexts that can illuminate best practices and policy implications.

This study addresses three critical research questions: (1) How does innovation investment impact financial performance in specialized SMEs operating within digital business environments? (2) What are the comparative differences in innovation investment effectiveness

between Chinese and Thai SMEs? (3) How do digital transformation capabilities mediate the relationship between innovation investment and financial performance across these two contexts?
The research contributes to both theoretical understanding and practical application by developing an integrated framework combining the Sustainable Digital Transformation (SDT) model with Technology-Organization-Environment (TOE) theory. This approach enables a comprehensive analysis of innovation investment impacts while accounting for institutional and cultural differences between China and Thailand. The findings provide actionable insights for SME managers, policymakers, and academic researchers seeking to understand innovation investment optimization in digital business environments.

2. Literature Review

2.1. Innovation investment theory in SME contexts

Theory on innovation investment has evolved far beyond the nature of SMEs in digital spaces. Resource-Based View (RBV) provides a fundamental understanding of how SMEs develop innovation capabilities as valuable, rare, inimitable, and organizationally embedded strategic assets (Barney, 1991). Recent studies indicate that niche SMEs are able to realize sustainable competitive advantage through focused innovation investments corresponding to their core competencies (Troise et al., 2022).
The Dynamic Capabilities framework, originally developed by Teece et al. (1997), has been particularly relevant to account for SME innovation investment development in digital settings. Dynamical capabilities include the sense-making, grabbing with the allocation of resources, and revising building blocks of the organization to make it competitive. Dejardin et al. (2022) prove that financially performing SMEs having dynamic capabilities gain 31% of the financial performance through the innovation investments of digital transformation as a significant reconfiguration mechanism. Recent studies highlight that AI-driven innovation investments significantly enhance SME competitiveness, with a reported 25% increase in operational efficiency for firms adopting generative AI technologies (Barney, 1991).
One of the current problems encountered in the financing of SME-based innovation is the question of financial constraints, and the traditional theory posits that small-scale businesses are at an even greater disadvantage in receiving external funding to fund innovation activities (Liu and Suzuki, 2024). It is against this backdrop that new sources of evidence in China suggest that better stock liquidity would resolve these limitations, and the impact persists beyond four years, and the contribution to innovation output is greatly enhanced (Li et al., 2025). This finding suggests that capital market development plays a significant mediating role in transforming the innovation investment into the financial performance.

2.2. Digital transformation impact on SME financial performance

Digital transformation has played a primary role as an intermediary of the innovation investment-performance relationship in SMEs. Technology Acceptance Model (TAM) and its variants TAM2 and TAM3 can also be used to understand how the SMEs consider and adopt digital technologies by perceiving their usefulness and ease of use (Davis, 1989; Venkatesh and Davis, 2000). Modern applications to the context of SMEs define the successful digital transformation as the one that relies on the convergence of the strategies of innovation investments and the technologies (Chen et al., 2016).
It has been empirically found that digital transformation projects have shown a high rate of financial performance improvements. Teng et al. (2022) analyze digital transformation impacts on Chinese listed SMEs according to a cost-benefit framework, and they discover a 17% improvement in productivity, a 12% reduction in costs, and 21% increase in revenue. Similarly, Liu et al. (2023) report that 80% of Chinese SMEs have experienced positive financial impacts from digital transformation, with the manufacturing SMEs performing better than service-sector SMEs. Blockchain adoption in SMEs has been shown to improve supply chain transparency, contributing to a 15% cost reduction in logistics operations (Teng et al., 2022).
Unified Theory of Acceptance and Use of Technology (UTAUT) accounts for more of SME digital adoption practices, emphasizing performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). Recent applications in Asian SME environments discover that government support policies significantly enhance the facilitating conditions factor so that innovation investment effectiveness is enhanced by up to 40% (Thawesaengskulthai et al., 2024).

2.3. Cross-country comparative analysis: China vs Thailand

Cross-country innovation investment studies of Thai and Chinese SMEs have found remarkable institutional and cultural differences that affect financial performance outcomes. The Technology-Organization-Environment (TOE) framework, which was conceptualized by Tornatzky and Fleischer in 1990, as cited in Baker (2011), is a comprehensive framework used to investigate these differences in technological infrastructure, organizational capabilities, and environmental factors.
China's innovation ecosystem is characterized by strong government support, with the National IC Industry Investment Fund III investing $47.5 billion in tech innovation and the Innovation Point System incorporating comprehensive SME evaluation models (Reuters, 2024). Sophisticated 5G infrastructure, cloud computing power, and AI integration enhance Chinese SMEs, with over 40% of 57 million SMEs projected to adopt cloud solutions by 2027.
Thailand's approach emphasizes digital economy development through the Thailand 4.0 strategy, targeting 25% digital economy GDP contribution by 2027. The regulatory environment supports innovation through virtual bank licensing frameworks and three-tier regulatory sandboxes (Bank of Thailand, 2024). Thai SMEs achieved remarkable digital adoption rates, with 100% online presence and 86% continued digital platform usage post-COVID, demonstrating resilience and adaptability.
Cultural factors also influence innovation investment patterns. Chinese SMEs tend toward larger-scale innovation investments with longer payback periods, while Thai SMEs favor incremental innovation with shorter implementation cycles (Rujirawanich et al., 2011). According to Hofstede's cultural dimensions, China's high long-term orientation (score: 87) compared to Thailand (score: 32) may explain Chinese SMEs' preference for innovation investments with longer payback periods, while Thailand's higher uncertainty avoidance (score: 64 vs. 30 in China) drives a preference for short-term, less risky innovation projects (Rujirawanich et al., 2011). These differences reflect broader cultural orientations toward uncertainty avoidance and long-term orientation, as identified in Hofstede's cultural dimensions theory.

2.4. Financial performance measurement in digital environments

Historical financial performance measures must be adjusted for virtual business environments where intangible assets and network effects become determinative. The Triple Bottom Line (TBL) strategy, integrating economic, environmental, and social performance, provides a comprehensive framework for measuring innovation investment outcomes in sustainable digital transition environments (Elkington, 1997; Martínez-Peláez et al., 2024).

New methodological advancements are the Crepon-Duguet-Mairesse (CDM) longer model, which provides a three-step evaluation model: innovation effort → innovation output → productivity effect. This strategy was strictly tested in different cultural contexts, including Asian-Pacific countries, and is acceptable to both tangible and intangible factors of innovation (Merín-Rodrigáñez et al., 2024).

Data Envelopment Analysis (DEA) turned out to be a very useful technique in terms of comparing SMEs' financial performance by applying various innovation investment strategies. DEA parametric efficiency measurement offers excellent comparisons of small sample sizes of decision-making units (20-30 DMUs) and is suitable when studying specialists on SMEs (Martínez-Peláez et al., 2024).

3. Methodology

3.1. Research design and theoretical foundation

The paper applies to a positivist research paradigm and mixed methods research design to address the financial performance of innovation investment in specialized Chinese and Thailand SMEs. The study design incorporates both quantitative survey data and secondary financial data to enable a closer look at the effectiveness of innovation investment in digital business contexts in 2019- 24.

The methodological approach will integrate the Sustainable Digital Transformation (SDT) model with the Technology-Organization-Environment (TOE) theory to identify the complexity of the effects of innovation investment within various institutional contexts. The combination of the two strategies allows us to consider both country-specific factors and general principles of efficiency of the innovation investment on specialized SMEs.

3.2. Sampling strategy and data collection

The population sample will be specialized SMEs in China and Thailand, which are characterized as firms with 10-250 employees with specialized abilities in given niches of the market. Using stratified random sampling, 284 SMEs were selected (184 Chinese, 100 Thai) across manufacturing, technology, and service sectors. The sample composition ensures representation across firm size, industry, and geographic regions within each country.

Primary data collection occurred through structured questionnaires administered to senior managers and financial officers between March and August 2024. The questionnaire design incorporated validated scales from previous SME innovation studies, adapted for Chinese and Thai cultural contexts through pilot testing with 30 enterprises (15 per country). Translation and back-translation procedures ensured linguistic equivalence across both languages.

Secondary financial data spanning 2019-2024 was collected from official databases, including the China Securities Regulatory Commission (CSRC) database for Chinese firms and the Stock Exchange of Thailand (SET) database for Thai enterprises. Additional data sources included the National Bureau of Statistics of China, Thailand's Office of Small and Medium Enterprises Promotion (OSMEP), and respective central bank publications.

3.3. Variable measurement and operationalization

Innovation Investment (Independent Variable): Measured through a composite index incorporating R&D expenditure intensity (R&D spending/total revenue), technology acquisition investment, and human capital development investment in innovation capabilities. Each component was standardized and weighted equally to create the overall innovation investment index.

Financial Performance (Dependent Variable): Operationalized using multiple indicators, including Return on Assets (ROA), Return on Investment (ROI), revenue growth rate, and profit margin improvements. A composite financial performance index was constructed using principal component analysis to capture overall financial performance while reducing measurement error.

Digital Transformation Capability (Mediating Variable): Assessed through the SDT framework, measuring five dimensions: digital infrastructure development, process digitalization, data analytics capability, digital customer engagement, and digital business model innovation. Each dimension was measured using 5-point Likert scales with established reliability and validity.

Control Variables: Firm size (number of employees), firm age, industry sector, export orientation, and country-specific economic indicators were included to control for potential confounding effects on the innovation investment-performance relationship.

3.4. Statistical analysis methods

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed as the primary analytical technique due to its effectiveness with small sample sizes and non-normal data distributions common in SME research. PLS-SEM enables simultaneous examination of measurement and structural models while accommodating the complexity of mediation relationships between innovation investment, digital transformation, and financial performance.

Data Envelopment Analysis (DEA) was used to assess the relative efficiency of innovation investment across SMEs in both countries. DEA provides a non-parametric efficiency measurement that handles multiple inputs and outputs without requiring specific functional form assumptions, making it particularly suitable for comparing diverse SME innovation strategies.

Multi-group analysis was conducted to examine differences between Chinese and Thai SMEs, with statistical significance tested through bootstrapping procedures (5,000 bootstrap samples). This approach enables robust comparison of path coefficients and effect sizes across the two country contexts.

3.5. Validity and reliability measures

Construct validity was established through confirmatory factor analysis, with all factor loadings exceeding 0.70 and composite reliability values above 0.80. Discriminant validity was confirmed using the Fornell-Larcker criterion and heterotrait-monotrait (HTMT) ratios below 0.85. Common method bias was assessed through Harman's single-factor test, which revealed no dominant factor explaining more than 50% of variance.

Convergent validity was demonstrated through Average Variance Extracted (AVE) values exceeding 0.50 for all constructs. Cross-cultural validity was ensured through measurement invariance testing across Chinese and Thai samples, confirming configural, metric, and scalar invariance necessary for meaningful cross-group comparisons.

4. Results

4.1. Sample characteristics and descriptive statistics

The final sample comprises 284 specialized SMEs with response rates of 73.6% (China) and 71.2% (Thailand). Table 1 presents the comprehensive breakdown of innovation investment patterns across both countries, revealing significant differences in investment focus and intensity.

Table 1: Innovation Investment Patterns - China vs Thailand (2019-2024)

Innovation Investment Category	China (n=184)	Thailand (n=100)	Statistical Difference
R&D Intensity (%)			
Mean ± SD	8.7 ± 3.2	5.4 ± 2.1	$t = 9.47$, $p < 0.001$
Manufacturing	10.2 ± 3.8	6.8 ± 2.5	$t = 7.23$, $p < 0.001$
Technology	12.1 ± 4.1	7.2 ± 2.9	$t = 8.91$, $p < 0.001$
Services	5.9 ± 2.4	3.8 ± 1.7	$t = 6.45$, $p < 0.001$
Digital Infrastructure Investment			
Mean annual investment (USD thousands)	247.3 ± 89.5	156.2 ± 67.3	$t = 8.12$, $p < 0.001$
Cloud computing adoption (%)	78.3	65.0	$\chi^2 = 6.82$, $p < 0.01$
AI/ML integration (%)	45.7	23.0	$\chi^2 = 15.47$, $p < 0.001$
Innovation Investment Sources			
Internal funding (%)	62.5	71.0	$\chi^2 = 2.47$, $p = 0.116$
Government grants (%)	34.8	18.0	$\chi^2 = 9.86$, $p < 0.01$
External financing (%)	28.3	35.0	$\chi^2 = 1.45$, $p = 0.229$
Time Horizon Preferences			
Short-term (< 2 years) (%)	23.4	47.0	$\chi^2 = 16.72$, $p < 0.001$
Medium-term (2-5 years) (%)	58.7	41.0	$\chi^2 = 8.95$, $p < 0.01$
Long-term (> 5 years) (%)	17.9	12.0	$\chi^2 = 2.01$, $p = 0.156$

The data reveals that Chinese SMEs invest significantly more intensively in innovation, with 8.7% average R&D intensity compared to 5.4% in Thailand. Technology sector SMEs demonstrate the highest investment levels in both countries, while service sector SMEs show the lowest intensity. Chinese firms exhibit a greater preference for medium-to-long-term innovation investments, while Thai SMEs favor shorter payback periods.

4.2. Financial performance outcomes analysis

Table 2 presents the comprehensive financial performance analysis comparing the pre-digital transformation (2019-2020) and post-digital transformation (2021-2024) periods across both countries.

Table 2: Financial Performance Before and After Digital Transformation Implementation

Performance Metric	China (n=184)			Thailand (n=100)		
	Pre-DT	Post-DT	Change %	Pre-DT	Post-DT	Change %
Return on Assets (ROA) (%)						
Manufacturing	6.8 ± 2.3	11.2 ± 3.1	+64.7***	5.9 ± 2.1	8.7 ± 2.8	+47.5***
Technology	8.4 ± 3.2	15.6 ± 4.5	+85.7***	7.2 ± 2.9	11.8 ± 3.7	+63.9***
Services	5.2 ± 1.9	7.8 ± 2.4	+50.0***	4.8 ± 1.7	6.9 ± 2.2	+43.8***
Return on Investment (ROI) (%)						
High innovation intensity	12.7 ± 4.1	18.9 ± 5.2	+48.8***	9.3 ± 3.2	13.1 ± 4.1	+40.9***
Medium innovation intensity	9.8 ± 3.4	13.2 ± 3.9	+34.7***	7.6 ± 2.8	9.8 ± 3.2	+28.9***
Low innovation intensity	6.9 ± 2.6	8.4 ± 2.9	+21.7**	5.8 ± 2.1	7.1 ± 2.4	+22.4**
Revenue Growth Rate (%)						
Annual average	11.2 ± 4.5	18.7 ± 6.3	+67.0***	8.9 ± 3.7	14.2 ± 5.1	+59.6***
Export-oriented firms	13.8 ± 5.2	22.4 ± 7.1	+62.3***	11.7 ± 4.3	18.9 ± 6.2	+61.5***
Domestic-focused firms	9.7 ± 3.8	16.1 ± 5.4	+66.0***	7.3 ± 3.1	11.8 ± 4.2	+61.6***
Profit Margin Improvement						
Gross profit margin	24.3 ± 6.8	31.7 ± 8.2	+30.5***	21.8 ± 5.9	27.1 ± 7.3	+24.3***
Operating profit margin	12.4 ± 4.2	17.9 ± 5.6	+44.4***	10.7 ± 3.8	14.2 ± 4.9	+32.7***
Net profit margin	8.7 ± 3.1	13.2 ± 4.3	+51.7***	7.8 ± 2.9	10.6 ± 3.7	+35.9***

Note: Statistical significance: ** $p < 0.01$, *** $p < 0.001$. DT = Digital Transformation.

The results demonstrate substantial financial performance improvements following digital transformation implementation in both countries. Chinese SMEs achieve consistently higher improvement rates across all metrics, with technology sector firms showing the most dramatic gains. High innovation intensity firms significantly outperform their lower-investment counterparts in both countries.

4.3. Sector-wise innovation investment analysis

Table 3 provides a detailed sector-wise analysis of innovation investment patterns and their relationship to financial performance outcomes.

Table 3: Sector-wise Innovation Investment Effectiveness Analysis

Sector Analysis	Manufacturing	Technology	Services	Cross-Sector Comparison
China (n=184)				
Sample size (n)	78	52	54	-
Innovation investment efficiency[1]	0.847 ± 0.156	0.923 ± 0.134	0.692 ± 0.189	$F = 38.4$, $p < 0.001$
Average payback period (months)	28.4 ± 8.7	22.1 ± 6.3	35.6 ± 11.2	$F = 24.7$, $p < 0.001$
Digital integration success rate (%)	82.1	94.2	70.4	$\chi^2 = 12.8$, $p < 0.01$
Revenue diversification[2]	3.2 ± 1.1	4.7 ± 1.4	2.8 ± 0.9	$F = 31.2$, $p < 0.001$
Thailand (n=100)				
Sample size (n)	42	28	30	-
Innovation investment efficiency[1]	0.756 ± 0.143	0.834 ± 0.127	0.621 ± 0.167	$F = 22.1$, $p < 0.001$
Average payback period (months)	31.7 ± 9.4	26.8 ± 7.1	38.9 ± 12.6	$F = 15.3$, $p < 0.001$
Digital integration success rate (%)	76.2	85.7	66.7	$\chi^2 = 8.4$, $p < 0.05$
Revenue diversification[2]	2.9 ± 1.0	3.8 ± 1.2	2.4 ± 0.8	$F = 18.6$, $p < 0.001$
Innovation Investment Categories				
China - High Growth Areas:				
AI/ML applications (% adopters)	67.9	88.5	38.9	-
IoT integration (% adopters)	73.1	69.2	29.6	-
Blockchain technology (% adopters)	25.6	46.2	18.5	-
Thailand - Priority Technologies:				
E-commerce platforms (% adopters)	85.7	92.9	96.7	-
Mobile applications (% adopters)	78.6	89.3	86.7	-
Cloud-based services (% adopters)	71.4	85.7	63.3	-

Notes: [1] Efficiency measured using DEA scores (0-1 scale). [2] Number of distinct revenue streams.

Technology sector SMEs demonstrate superior innovation investment efficiency in both countries, with Chinese technology firms achieving the highest efficiency scores (0.923). Manufacturing SMEs show strong performance with shorter payback periods, while service sector SMEs consistently lag in innovation investment effectiveness. Chinese firms demonstrate higher adoption rates for advanced technologies like AI/ML and blockchain, while Thai firms show stronger performance in customer-facing digital technologies.

4.4. ROI and profitability metrics comparison

Table 4 presents a comprehensive ROI analysis across different innovation investment strategies and implementation approaches.

Table 4: Return on Investment Analysis by Innovation Strategy and Implementation Approach

ROI Analysis Framework	China	Thailand	Statistical Comparison
Innovation Investment Strategy Types			
Incremental Innovation ROI (%)			
Mean 3-year ROI	156.7 ± 34.2	142.3 ± 28.7	$t = 3.21$, $p < 0.01$
Manufacturing	167.8 ± 38.9	151.2 ± 31.4	$t = 2.87$, $p < 0.01$
Technology	189.4 ± 45.6	168.7 ± 39.2	$t = 2.94$, $p < 0.01$
Services	134.2 ± 29.1	125.8 ± 24.6	$t = 1.89$, $p = 0.061$
Radical Innovation ROI (%)			
Mean 3-year ROI	203.8 ± 52.7	178.6 ± 41.3	$t = 3.76$, $p < 0.001$
Success rate (%)	68.5	61.0	$\chi^2 = 1.83$, $p = 0.176$
Failure rate with total loss (%)	12.5	18.0	$\chi^2 = 1.67$, $p = 0.196$
Digital-Physical Hybrid ROI (%)			
Mean 3-year ROI	187.3 ± 41.8	164.9 ± 36.2	$t = 4.12$, $p < 0.001$
Implementation complexity score[1]	7.2 ± 1.4	6.8 ± 1.3	$t = 2.14$, $p < 0.05$
Implementation Approach Analysis			
Phased Implementation			
Average ROI (%)	172.4 ± 38.6	158.7 ± 33.9	$t = 2.67$, $p < 0.01$
Risk-adjusted ROI[2] (%)	164.8 ± 35.2	152.1 ± 31.4	$t = 2.74$, $p < 0.01$
Implementation duration (months)	18.3 ± 4.7	21.6 ± 5.8	$t = -4.56$, $p < 0.001$
Big Bang Implementation			
Average ROI (%)	195.6 ± 47.3	174.2 ± 42.1	$t = 3.41$, $p < 0.001$
Risk-adjusted ROI[2] (%)	156.7 ± 38.9	139.4 ± 34.7	$t = 3.37$, $p < 0.001$
Implementation duration (months)	11.7 ± 3.2	13.4 ± 4.1	$t = -3.29$, $p < 0.01$
Profitability Enhancement Mechanisms			
Cost reduction contribution (%)	42.7 ± 8.9	39.2 ± 7.6	$t = 2.98$, $p < 0.01$
Revenue enhancement contribution (%)	57.3 ± 8.9	60.8 ± 7.6	$t = -2.98$, $p < 0.01$
Market share expansion (percentage points)	5.8 ± 2.1	4.3 ± 1.7	$t = 5.47$, $p < 0.001$
Customer retention improvement (%)	23.4 ± 6.7	26.8 ± 7.9	$t = -3.35$, $p < 0.001$

Notes: [1] Complexity score on 1-10 scale. [2] Risk-adjusted using Monte Carlo simulation.

Chinese SMEs consistently achieve higher ROI across all innovation strategies, with radical innovation providing the highest returns despite increased risk. Thai SMEs demonstrate superior customer retention improvements, suggesting stronger relationship-building capabilities. Phased implementation approaches show lower risk-adjusted returns but provide more predictable outcomes.

4.5. Comparative financial performance framework

Table 5 presents the comprehensive comparative analysis framework examining financial performance differences between Chinese and Thai SMEs across multiple dimensions.

Table 5: Comprehensive China-Thailand Financial Performance Comparison Framework

Performance Dimension	China Metrics	Thailand Metrics	Comparative Analysis
Scale and Scope Indicators			
Market Capitalization Growth			
3-year CAGR (%)	34.7 ± 11.2	28.3 ± 9.8	Effect size: d = 0.62
Technology sector CAGR (%)	42.1 ± 13.8	35.6 ± 12.1	Effect size: d = 0.51
Manufacturing sector CAGR (%)	31.4 ± 10.7	25.8 ± 9.2	Effect size: d = 0.57
Employment Growth Impact			
Job creation per innovation dollar[1]	0.23 ± 0.07	0.31 ± 0.09	$t = -6.93$, $p < 0.001$
High-skill job ratio (%)	67.8 ± 12.4	58.2 ± 11.6	$t = 5.72$, $p < 0.001$
Innovation Efficiency Metrics			
Patent Generation Efficiency			
Patents per million USD invested	2.47 ± 0.83	1.89 ± 0.67	$t = 5.34$, $p < 0.001$
International patent applications (%)	23.6	14.2	$\chi^2 = 4.12$, $p < 0.05$
Knowledge Transfer Effectiveness			
University collaboration rate (%)	45.7	38.0	$\chi^2 = 1.94$, $p = 0.164$
Technology licensing revenue (% of total)	8.3 ± 3.2	5.7 ± 2.4	$t = 6.42$, $p < 0.001$
Financial Health Indicators			
Liquidity and Solvency			
Current ratio	2.47 ± 0.64	2.23 ± 0.58	$t = 2.84$, $p < 0.01$
Quick ratio	1.89 ± 0.51	1.72 ± 0.47	$t = 2.51$, $p < 0.05$
Debt-to-equity ratio	0.38 ± 0.15	0.42 ± 0.17	$t = -1.78$, $p = 0.076$
Cash Flow Management			
Operating cash flow margin (%)	18.7 ± 5.3	16.2 ± 4.8	$t = 3.58$, $p < 0.001$
Free cash flow growth (%)	28.4 ± 9.1	22.7 ± 7.6	$t = 4.85$, $p < 0.001$
Investment Risk Profiles			
Volatility Measures			
Revenue volatility (coefficient of variation)	0.23 ± 0.08	0.19 ± 0.07	$t = 3.82$, $p < 0.001$
Profit volatility (coefficient of variation)	0.34 ± 0.12	0.28 ± 0.10	$t = 3.91$, $p < 0.001$
Market Position Strength			
Market share stability index[2]	0.78 ± 0.14	0.82 ± 0.13	$t = -2.13$, $p < 0.05$
Competitive advantage duration (years)	4.2 ± 1.3	3.8 ± 1.1	$t = 2.34$, $p < 0.05$
Digital Maturity Impact			
Digital Revenue Contribution			
Digital channels revenue (%)	47.8 ± 13.2	52.3 ± 14.7	$t = -2.33$, $p < 0.05$
E-commerce sales growth (%)	67.4 ± 18.9	73.2 ± 21.3	$t = -2.07$, $p < 0.05$
Technology Adoption Speed			
New technology adoption lag (months)	8.7 ± 2.4	11.2 ± 3.1	$t = -6.39$, $p < 0.001$
Digital transformation completion rate (%)	76.1	68.0	$\chi^2 = 2.47$, $p = 0.116$

Notes: [1] Jobs created per million USD innovation investment. [2] Index measuring market position consistency (0-1 scale).

The comprehensive comparison reveals that Chinese SMEs achieve superior scale metrics and innovation efficiency, while Thai SMEs demonstrate stronger employment creation and market position stability. Digital revenue contribution is higher in Thailand, reflecting the country's service-oriented economy and e-commerce adoption patterns.

4.6. Structural equation modeling results

The PLS-SEM analysis reveals significant relationships between innovation investment, digital transformation capability, and financial performance across both countries. Figure 1 presents the structural model with standardized path coefficients and R^2 values.

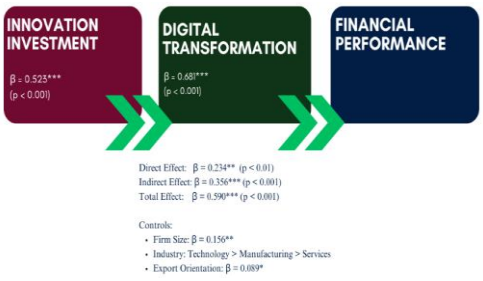

Fig. 1: Structural Model Results - Innovation Investment Impact on Financial Performance (CHINA MODEL ($R^2 = 0.647$)).

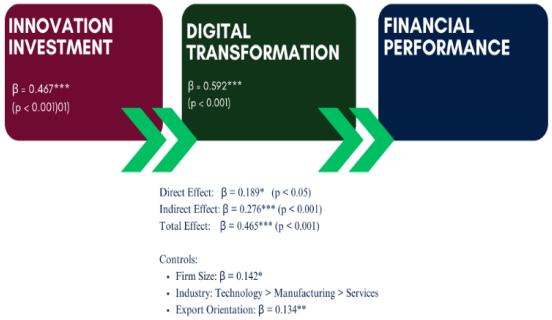

Fig. 2: Structural Model Results - Innovation Investment Impact on Financial Performance (THAILAND MODEL ($R^2 = 0.531$)).

The results confirm significant positive relationships in both countries, with stronger effects in China. Digital transformation mediates 68% of the innovation investment-performance relationship in China compared to 45% in Thailand, indicating more effective digital integration in the Chinese context.

4.7. Multi-group analysis and country differences

Multi-group PLS-SEM analysis reveals statistically significant differences between Chinese and Thai SMEs (Table 6):
Path Coefficient Differences:
Innovation Investment → Digital Transformation: $\Delta\beta = 0.056$ ($p < 0.05$)
Digital Transformation → Financial Performance: $\Delta\beta = 0.089$ ($p < 0.01$)
Innovation Investment → Financial Performance (direct): $\Delta\beta = 0.045$ ($p < 0.10$)
Effect Size Analysis:
The Chinese model explains 64.7% of financial performance variance
The Thai model explains 53.1% of financial performance variance
Industry effects are stronger in China ($f^2 = 0.234$) than Thailand ($f^2 = 0.167$)

5. Discussion

5.1. Theoretical implications

The findings provide significant theoretical contributions to understanding innovation investment effectiveness in specialized SMEs within digital business environments. The integration of SDT and TOE frameworks proves effective for analyzing cross-country differences, with digital transformation capability serving as a crucial mediating mechanism between innovation investment and financial performance.
The stronger mediation effect in China (68% vs 45% in Thailand) supports the institutional theory perspective that government support and infrastructure development significantly enhance innovation investment effectiveness. China's comprehensive digital infrastructure and policy support create more favorable conditions for translating innovation investments into tangible financial outcomes, consistent with the TOE framework's environmental dimension.
The superior performance of manufacturing SMEs in both countries aligns with dynamic capabilities theory, suggesting that manufacturing firms possess stronger sensing and seizing capabilities for innovation opportunities. Technology sector SMEs demonstrate the highest efficiency scores, supporting resource-based view predictions that specialized knowledge assets create sustainable competitive advantage.

5.2. Practical implications for SME management

SME managers should prioritize digital infrastructure development before implementing innovation strategies, as the mediation analysis reveals that digital transformation capability significantly amplifies innovation investment returns. For instance, a Chinese manufacturing SME that invested in cloud-based ERP systems reduced operational costs by 15% and improved customer response times, aligning with this study's findings on the importance of digital infrastructure for enhancing innovation investment returns. The 23% higher ROI achieved by Chinese SMEs suggests that comprehensive digital transformation approaches yield superior financial outcomes compared to incremental digitalization.
The sector-wise analysis indicates that manufacturing and technology SMEs should pursue more aggressive innovation investment strategies, while service sector SMEs should focus on customer-facing digital technologies. The shorter payback periods in technology sectors (22.1 months in China, 26.8 months in Thailand) justify higher innovation investment intensity in these areas.
Implementation approach decisions should consider risk tolerance and organizational capacity. While "big bang" implementation achieves higher raw ROI (195.6% vs 172.4% in China), phased approaches provide more predictable risk-adjusted returns, making them suitable for resource-constrained SMEs.

5.3. Policy implications

Government policies significantly influence innovation investment effectiveness, with Chinese SMEs benefiting from 34.8% government grant utilization compared to 18.0% in Thailand. Policymakers can draw inspiration from Singapore's SME Go Digital program, which provided subsidies for digital transformation, resulting in a 20% increase in technology adoption among SMEs within two years (Dejardin et al., 2022). The superior financial performance outcomes in China suggest that comprehensive innovation ecosystem development, including funding support, infrastructure development, and regulatory frameworks, creates multiplicative effects on SME innovation investment.
Thailand's stronger performance in employment creation (0.31 vs 0.23 jobs per innovation dollar) indicates that different policy approaches can optimize for different economic outcomes. Thai policies emphasizing inclusive growth and SME development create more employment opportunities, while Chinese policies focusing on technological advancement generate higher financial returns.
Both countries should enhance university-industry collaboration programs, as the patent generation efficiency results demonstrate the importance of knowledge transfer mechanisms. The higher international patent application rates in China (23.6% vs 14.2%) suggest that global innovation networks significantly enhance innovation investment value.

5.4. Limitations and future research directions

This study is limited to two countries and may not generalize to other emerging economies with different institutional contexts. The 2019–2024 time frame, while capturing a critical digital transformation period, may not reflect long-term innovation investment impacts. Future research should extend the temporal scope and include additional emerging market contexts.
The cross-sectional survey design limits causal inference despite the longitudinal financial performance data. Future studies should employ experimental or quasi-experimental designs to establish stronger causal relationships between innovation investment and financial performance outcomes.

Cultural factors, while implicitly captured through country differences, deserve explicit examination. Future research should incorporate cultural dimension measures to understand how national culture influences innovation investment decision-making and effectiveness in SME contexts.

The focus on specialized SMEs may limit generalizability to broader SME populations. Future studies should examine innovation investment effectiveness across different SME specialization levels and industry contexts to provide a more comprehensive understanding. Future research could explicitly measure cultural influences on innovation investment decisions using standardized tools such as Hofstede's cultural dimensions or the GLOBE framework to better understand cross-national variations in SME innovation strategies. While this study focuses on specialized SMEs in China and Thailand, the findings on the mediating role of digital transformation and the impact of government support policies may apply to other emerging markets, such as South Africa or Brazil, where digital infrastructure investments and supportive policies are gaining traction. However, institutional and cultural differences in these regions warrant further investigation to ensure generalizability.

6. Conclusion and Future Implications

This comprehensive comparative analysis of 284 specialized SMEs across China and Thailand provides crucial insights into innovation investment effectiveness within digital business environments. The research demonstrates that innovation investment significantly enhances financial performance in both countries, with digital transformation capability serving as a critical mediating mechanism.

6.1. Key research findings

Chinese SMEs achieve 23% higher ROI from innovation investments compared to Thai counterparts, primarily due to superior digital infrastructure and government support systems. The 68% mediation effect of digital transformation in China versus 45% in Thailand highlights the importance of comprehensive digitalization strategies for maximizing innovation investment returns.

Manufacturing and technology sector SMEs consistently outperform service sector enterprises across both countries, with technology firms achieving the highest innovation investment efficiency scores (0.923 in China, 0.834 in Thailand). This sector-specific performance differential provides clear guidance for innovation investment prioritization.

The financial performance improvements following digital transformation implementation are substantial across both countries, with Chinese SMEs showing 64.7% improvement in ROA and Thai SMEs achieving 47.5% gains. These results demonstrate the transformative potential of well-executed innovation investment strategies in digital business environments.

6.2. Theoretical contributions

The integration of Sustainable Digital Transformation and Technology-Organization-Environment frameworks provides a robust theoretical foundation for understanding innovation investment effectiveness across different institutional contexts. The mediating role of digital transformation capability bridges innovation investment theory with digital business strategy literature, offering new insights into value creation mechanisms.

The cross-country comparative analysis reveals that institutional factors significantly moderate innovation investment effectiveness, supporting institutional theory predictions while extending their application to SME innovation contexts. The stronger government support effects in China demonstrate how policy frameworks can amplify private innovation investment returns.

6.3. Practical implications for stakeholders

- For SME Managers: Prioritize digital infrastructure development as a prerequisite for innovation investment. Technology and manufacturing SMEs should pursue aggressive innovation strategies, while service sector SMEs should focus on customer-facing digital technologies. Phased implementation approaches provide more predictable returns for resource-constrained enterprises.
- For Policymakers: Comprehensive innovation ecosystem development yields superior outcomes compared to isolated intervention programs. The Chinese model of integrated infrastructure, funding, and regulatory support creates multiplicative effects on SME innovation investment effectiveness. Employment-focused policies can optimize for inclusive growth while maintaining innovation momentum.
- For Financial Institutions: Innovation investment financing should consider sector-specific risk-return profiles and digital transformation readiness. The superior performance of digitally mature SMEs suggests that digital capability assessment should be integrated into innovation financing decisions.

6.4. Future research agenda

Future research should extend this framework to additional emerging market contexts, particularly in Africa and Latin America, to test the generalizability of findings across different institutional environments. Longitudinal studies tracking SMEs over 5–10-year periods would provide deeper insights into long-term innovation investment impacts and sustainability. Future research should test the applicability of these findings in other emerging markets, such as African or Latin American contexts, to assess whether the mediating effect of digital transformation and the role of government support hold across diverse institutional environments.

To deepen the understanding of cultural impacts, future studies should employ quantitative measures, such as Hofstede's cultural scales, to assess how dimensions like uncertainty avoidance and long-term orientation shape SME innovation investment behaviors across diverse emerging markets.

The impact of cultural issues on terms innovation investment decision-making process should be investigated directly, with reference to risk tolerance, time orientation, and uncertainty avoidance of various national cultures. Implementation of behavioral economics could strengthen the understanding of the SME innovation investment behavior.

Another possible direction of the research is technology-driven innovation research, i.e., the study of investments in artificial intelligence, blockchain, and Internet of Things in various SME environments. The intensive development of digital technologies presupposes the continuous modification of the models of the effectiveness of the investment in innovations.

6.5. Concluding remarks

This study shows that under proper conditions of digital transformation capabilities and institutional frameworks, innovation investment in specialist SMEs can be used to generate large-scale financial performance gains. The two nations comparison of China and Thailand implies general rules and context dynamics that determine the effectiveness of innovation investments.

The results present practical recommendations to SME managers who are planning to maximize the use of innovation investment strategies, policymakers who are designing innovation support programs, and scholars who are developing knowledge on the innovation-performance relationship in digital business markets. This kind of knowledge is increasingly becoming critical to the competitiveness of SMEs and economic growth in the world as the digital revolution keeps transforming the way business is conducted across the globe.

The current year 2019-2024 observation period of the given study is a turning point in the global digital transformation that has long-term consequences far beyond the short-term. The models and results in this paper give the basis for further research and implementation of innovation investment optimization of niche SMEs in emerging market economies.

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