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HOW DIGITAL ENTREPRENEURIAL ORIENTATION DRIVES PLATFORM INNOVATION: A MULTI-COUNTRY STUDY OF ORGANIZATIONAL AGILITY IN SOUTHEAST ASIAN DIGITAL ECONOMIES

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Abstract

This study investigates how digital entrepreneurial orientation drives platform innovation through organizational agility across Southeast Asian digital economies. Drawing on dynamic capabilities theory, this study analyzes 156 platform enterprises from Singapore, Indonesia, Thailand, and Malaysia using a mixed-methods approach combining structural equation modeling (SEM) and fuzzy-set qualitative comparative analysis (fsQCA). The findings reveal that organizational agility mediates 40.4% of the relationship between digital entrepreneurial orientation and platform innovation performance, with strategic sensitivity emerging as the strongest mediating dimension (17.0%). Cross-national analysis uncovers significant heterogeneity: Singapore exhibits a "weak direct-strong indirect" pattern reflecting capability-driven innovation in mature markets, while Indonesia shows a "strong direct-weak indirect" pattern characteristic of opportunity-driven innovation in emerging markets. The fsQCA identifies three equifinal paths to high innovation performance: "Digital Champion" (comprehensive excellence), "Agile Adaptation" (flexibility-based), and "Resource Integration" (scale-based). Notably, no single element proves universally necessary for innovation success, challenging traditional best-practice paradigms. These findings contribute to digital entrepreneurship literature by revealing the contingent nature of platform innovation and provide practical guidance for enterprises navigating diverse institutional contexts. The study demonstrates that successful platform innovation emerges not from universal models but from context-specific configurations of entrepreneurial orientation and organizational capabilities.

Keywords

Digital entrepreneurial orientation(1), Platform innovation(2), Organizational agility(3), Southeast Asian digital economy(4), Configurational analysis(5)

1. Introduction

The digital economy in Southeast Asia is experiencing unprecedented rapid growth, emerging as one of the most dynamic digital markets globally. According to recent data, the digital economy of the six major Southeast Asian economies reached $263 billion in 2024, with projections exceeding the $1 trillion threshold by 2030 (Al-Moaid & Almarhdi, 2024; Yu, 2024). Within this development wave, platform enterprises, serving as the core carriers of the digital economy, are reshaping the regional economic landscape through multi-sided market integration, value co-creation facilitation, and ecosystem evolution. However, amid increasingly fierce market competition, how platform enterprises can achieve sustainable competitive advantages through innovation has become a critical issue requiring urgent resolution. Digital entrepreneurial orientation, conceptualized as firms' strategic inclination to identify opportunities, assume risks, and proactively innovate within digital environments, is recognized as a crucial antecedent driving platform innovation (Kraus, Vonmetz, Bullini Orlandi, Zardini, & Rossignoli, 2023). Nevertheless, the mechanisms through which digital entrepreneurial orientation translates into actual innovation outcomes, particularly within the unique emerging market context of Southeast Asia, remain largely a "black box".

While existing research has examined the relationship between digital transformation and innovation, significant theoretical gaps persist. First, most studies focus on developed economies or single-country contexts, lacking cross-national comparative analyses of emerging markets, particularly the Southeast Asian region (Nadkarni & Prügl, 2021). Southeast Asian countries exhibit substantial heterogeneity in digital infrastructure, institutional environments, and market maturity, providing an ideal research setting for exploring the contextualized effects of digital entrepreneurial orientation. Second, although dynamic capabilities theory emphasizes the importance of firms' adaptation to environmental changes (Warner & Wäger, 2019), organizational agility as a critical mechanism linking entrepreneurial orientation and innovation performance has received limited in-depth investigation. Organizational agility encompasses three dimensions—strategic sensitivity, leadership unity, and resource fluidity (Gong & Ribiere, 2023)—enabling firms to rapidly respond to market changes and reconfigure resources, which is particularly crucial in dynamic digital environments. Furthermore, existing literature predominantly employs single research methods, making it challenging to comprehensively reveal complex causal relationships and configurational effects (Pappas & Woodside, 2021).

Addressing these research gaps, this study aims to explore how digital entrepreneurial orientation drives innovation performance of Southeast Asian platform enterprises through organizational agility, while examining the differential impact mechanisms across various national contexts. Specifically, this research seeks to answer three core questions: First, how does digital entrepreneurial orientation influence platform enterprises' innovation performance? Second, what mediating role does organizational agility play between digital entrepreneurial orientation and platform innovation? Third, how do institutional environments and digital development levels across different countries moderate

these relationships? To address these questions, this study employs a mixed-methods approach, conducting empirical analysis of 156 platform enterprises across Singapore, Indonesia, Thailand, and Malaysia. The research integrates structural equation modeling (SEM) and fuzzy-set qualitative comparative analysis (fsQCA), with the former examining linear relationships and mediation effects among variables, and the latter identifying multiple configurational paths leading to high innovation performance (Bachmann, Rose, Maul, & Hölzle, 2024).

The theoretical implications of this study are expressed through three distinct areas. Firstly, this study extends the boundaries of dynamic capabilities theory in the scenario of digital entrepreneurship, conceptualizing how digital ecosystems alter classical entrepreneurial mechanisms and innovation processes (Ellström, Holtström, Berg, & Josefsson, 2021). Secondly, it demonstrates the central role of organizational agility as a mediating variable, hence revealing the complexities of the influence that digital entrepreneurial orientation exerts on innovation. Thirdly, through a comparative framework that spans multiple countries, this research demonstrates how institutional environments and digital infrastructure act as moderating variables in the entrepreneurship-innovation relationship, thus providing empirical evidence for context-specific theories (Cha & Park, 2024). In practice, the findings of this research will benefit Southeast Asian platform companies in formulating digital transformation strategies that enable managers to grasp how to create a digital entrepreneurial culture, address organizational agility, and modify innovation strategies that are specific to their respective national environments. Additionally, these findings will be beneficial for policymakers who seek to build institutional frameworks that support the development of the platform economy.

2. Theoretical Framework and Hypotheses

2.1 Digital Entrepreneurial Orientation and Platform Innovation

Digital entrepreneurial orientation refers to the strategic inclination of companies to perceive and leverage entrepreneurial opportunities in digital environments, an enrichment of existing ideas of entrepreneurial orientation in the modern digital age. As defined by Tang et al. (Tang, Yao, Boadu, & Xie, 2022), digital entrepreneurial orientation includes three basic dimensions: innovativeness, by the tendency of companies to leverage digital technologies to develop new products, services, and business models; proactiveness, by the capacity of companies to act in anticipation of competitors in digital markets; and risk-taking, by the willingness of companies to invest in new technologies and explore new markets in face of uncertain digital situations. Each of these displays different characteristics in digital environments—innovativeness emphasizes the significance of data-driven iterative innovation, proactiveness focuses on the building of platform ecosystems, while risk-taking involves the tandem challenges of technology investment and business model transformation. Platform innovation differs from traditional product innovation, with value creation in multi-sided markets, network effects cultivation, and the development of cooperative ecosystems (Priyono & Hidayat, 2024). Through its provision of strategic leadership and guidance for resource allocation, digital entrepreneurial orientation enables platform companies to sense user demand shifts, develop innovative features, improve matching algorithms, and expand service scopes. According to Ritala et al. (Ritala, Baiyere, Hughes, & Kraus, 2021), companies with a strong digital entrepreneurial orientation are more likely to adopt open innovation approaches, hence enhancing their platform innovation competence through API

openness, developer community building, and third-party service integration. Digital entrepreneurial orientation also aids business model innovation in platform companies, enabling transitions from transactional platforms to innovation-based models and moving from single value chains to end-to-end value networks. Based on the above theoretical concepts, the following hypothesis is proposed:

H1: Digital entrepreneurial orientation positively influences platform innovation performance.

2.2 The Mediating Role of Organizational Agility

Organizational agility represents firms' dynamic capability to sense environmental changes, make rapid decisions, and flexibly adjust resource allocation, playing a crucial bridging role in digital transformation processes. Yildiz and Aykanat (Yildiz & Aykanat, 2021) conceptualize organizational agility as three interconnected dimensions: strategic sensitivity enables firms to timely detect market opportunities and threats through big data analytics and user behavior tracking for trend prediction; leadership unity ensures executive team decision consistency and execution coordination when facing change; resource fluidity guarantees firms' ability to rapidly reconfigure human, technological, and financial resources in response to new strategic demands. Digital entrepreneurial orientation provides the necessary cognitive foundation and strategic guidance for cultivating organizational agility, with highly digitally entrepreneurial-oriented firms placing greater emphasis on establishing flexible organizational structures, flat decision-making mechanisms, and cross-departmental collaboration networks (Idrees, Hynek, Xu, Akbar, & Jabeen, 2022). Simultaneously, organizational agility transforms digital entrepreneurial orientation into concrete innovation actions, accelerating innovation idea realization and market validation through rapid prototyping, agile iteration, and continuous deployment practices. Research by Shen et al. (Shen, Zhang, & Liu, 2022) demonstrates that organizational agility, by enhancing firms' learning and adaptive capabilities, enables continuous innovation in dynamic environments, particularly when facing technological change and market uncertainty—agile organizations can more rapidly adjust innovation direction and resource investment. In the platform economy, organizational agility is further manifested as rapid response to ecosystem partner needs, timely processing of user feedback, and proactive response to competitive threats. Therefore, organizational agility is not merely an outcome of digital entrepreneurial orientation but a necessary condition for its transformation into innovation performance. Drawing from this analysis, the proposal is:

H2: Organizational agility mediates the relationship between digital entrepreneurial orientation and platform innovation performance.

2.3 Differentiated Effects in National Contexts

Southeast Asian countries exhibit significant differences in digital economy development stages, institutional environments, and infrastructure, leading to varied mechanisms through which digital entrepreneurial orientation influences platform innovation across different nations. Singapore, as a regional digital hub, possesses comprehensive digital infrastructure, robust intellectual property protection systems, and mature venture capital ecosystems. In such environments, firms face intense market competition where mere entrepreneurial spirit cannot directly translate into competitive

advantage—innovation must be achieved through superior organizational capabilities. In contrast, Indonesia, despite relatively weak digital infrastructure, generates enormous market opportunities through its massive population (280 million) and rapidly growing internet penetration. In this high-growth, low-saturation market environment, digital entrepreneurial orientation itself can rapidly identify and capture innovation opportunities, with organizational agility playing a relatively secondary role (Xie et al., 2024).

Thailand and Malaysia are at critical stages of digital transformation, with proactive government policy support and increasingly sophisticated digital ecosystems providing unique development environments for platform innovation. Thailand's "Thailand 4.0" strategy and Malaysia's Digital Economy Blueprint both emphasize innovation-driven development, yet with market sizes and competitive intensities between Singapore and Indonesia, requiring firms to both leverage entrepreneurial spirit for opportunity capture and organizational capabilities for execution quality assurance. Institutional environment differences similarly influence innovation path selection. In institutionally mature Singapore, where intellectual property receives effective protection, firms tend to obtain sustainable competitive advantages through systematic R&D and organized innovation processes. In countries with relatively weak institutional environments, firms may rely more on rapid trial-and-error and market response for innovation, addressing environmental uncertainty through flexible strategic adjustments (Xiong, 2024).

Differences across countries in digital talent supply, consumer digital literacy, and industrial digitalization levels further reinforce country-specific innovation mechanism characteristics. Singapore's high-quality technical talent pool and mature innovation ecosystem facilitate organizational agility's transformation into actual innovation output. While Indonesia faces relative technical talent shortages, its young demographic structure and openness to new technologies provide favorable conditions for entrepreneurial innovation, potentially highlighting more prominent direct effects of digital entrepreneurial orientation. Mueller-Saegebrecht and Walter (Mueller-Saegebrecht & Walter, 2025) emphasize that firms' innovation strategies must align with their institutional and market environments—identical capability combinations may generate vastly different innovation outcomes across different national contexts. Based on this analysis, this study expects significant differences in the mechanisms through which digital entrepreneurial orientation influences platform innovation across the four countries, proposing:

H3: The direct effects of digital entrepreneurial orientation on platform innovation performance and indirect effects through organizational agility differ significantly across Singapore, Indonesia, Thailand, and Malaysia.

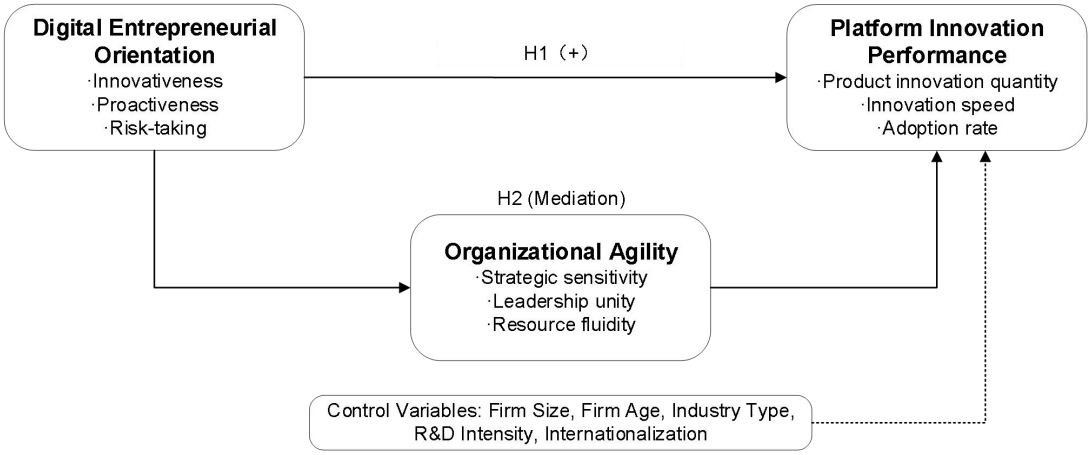


Figure 1 Research Theoretical Conceptual Model

Figure 1 presents this study's theoretical conceptual model, clearly illustrating the logical relationships among variables. In the model, digital entrepreneurial orientation serves as the antecedent variable, influencing platform innovation performance through its three dimensions of innovativeness, proactiveness, and risk-taking. Organizational agility, with its three dimensions of strategic sensitivity, leadership unity, and resource fluidity, plays a mediating role in this relationship, constructing the transformation path from strategic orientation to innovation outcomes. Platform innovation performance is measured through indicators including product innovation quantity, innovation speed, and adoption rates, reflecting multiple innovation dimensions. Solid arrows in the model represent the direct effect path of Hypothesis H1, while paths through organizational agility indicate the mediation mechanism of Hypothesis H2. Firm size, age, industry type, R&D intensity, and internationalization degree are included as control variables to exclude potential confounding factors. Notably, while national context does not appear as a moderating variable in the model, this study will test Hypothesis H3 through multi-group analysis, exploring differences in model path relationships across countries.

In summary, this chapter's research framework, built upon dynamic capabilities theory, provides theoretical guidance for exploring the internal mechanisms through which digital entrepreneurial orientation drives platform innovation. By integrating direct effects, mediation mechanisms, and cross-national difference analysis, a multi-level, contextualized theoretical model is formed. This model's unique value lies in: first, explicitly positioning organizational agility as the critical nexus connecting strategic intent with innovation output; second, fully considering the influence of differentiated institutional and market environments across Southeast Asian countries on innovation mechanisms through cross-national comparison; third, employing multi-dimensional measurement approaches to comprehensively capture the complexity of entrepreneurship and innovation in the digital age. This theoretical framework provides clear direction for the empirical research design in the next chapter while laying the foundation for testing and extending existing theory.

3. Research Methods

3.1 Research Context and Sample

This study selects four Southeast Asian countries—Singapore, Indonesia, Thailand, and Malaysia—as research contexts based on the following considerations. First, according to recent data, these four countries exhibit distinct gradient differences in platform economy development. Singapore hosts 20 unicorn enterprises, serving as Southeast Asia's innovation hub; Indonesia has 10 unicorns and, with its 280 million population, constitutes the region's largest digital economy, accounting for 40% of Southeast Asia's total digital economy; while Thailand and Malaysia have fewer unicorns (1-2 each), they are experiencing accelerated digital transformation, with government initiatives such as Thailand's "Thailand 4.0" strategy and Malaysia's Digital Economy Blueprint providing robust support for platform enterprise development (Felicetti, Corvello, & Ammirato, 2024). Second, platform enterprises in these four countries span major sectors including e-commerce (Shopee, Lazada, Tokopedia), mobility (Grab, Gojek), fintech, and logistics, demonstrating strong industry representativeness.

The research sample focuses on platform enterprises, defined as firms that connect multi-sided user groups and facilitate value exchange through digital technologies. Sample selection criteria include: (1) firms' core business operates based on digital platform models; (2) establishment for more than three years, ensuring firms have passed the startup phase; (3) employee size exceeding 30 persons, guaranteeing basic organizational structural integrity; (4) annual revenue exceeding $5 million or having received institutional investment. Through national digital economy associations, entrepreneurial ecosystem databases (such as Crunchbase, DealStreetAsia), and industry reports, 385 qualifying platform enterprises were initially identified. Following further screening and contact, 156 enterprises ultimately agreed to participate in the study, yielding an overall response rate of 40.5%. Table 3.1 presents the distribution characteristics of sample enterprises.

Table 1 Sample Enterprise Distribution Characteristics

Characteristics	Singapore	Indonesia	Thailand	Malaysia	Total	Percentage
Industry						
E-commerce	9	16	8	7	40	25.6%
Fintech	11	10	5	6	32	20.5%
Mobility & Logistics	7	12	9	6	34	21.8%
Food & Lifestyle	6	11	7	5	29	18.6%
Others	5	9	5	2	21	13.5%
Firm size						
30-100 employees	8	20	14	10	52	33.3%
101-500 employees	18	24	15	11	68	43.6%
>500 employees	12	14	5	5	36	23.1%
Firm age						
3-5 years	10	22	16	12	60	38.5%
6-10 years	19	21	13	10	63	40.4%
>10 years	9	15	5	4	33	21.1%

Characteristics	Singapore	Indonesia	Thailand	Malaysia	Total	Percentage
Funding stage						
Series A-B	15	26	18	14	73	46.8%
Series C+	18	18	10	8	54	34.6%
Listed/Acquired	5	14	6	4	29	18.6%
Total	38	58	34	26	156	100%

Table 1 indicates that the sample distribution reflects the actual development status of platform economies across countries. Indonesia has the largest sample size (58 firms, 37.2%), consistent with its position as Southeast Asia's largest digital economy; Singapore, despite its smaller market size, contributes 38 samples (24.4%) through its innovation ecosystem advantages; Thailand and Malaysia contribute 34 (21.8%) and 26 (16.6%) firms respectively. The industry distribution is balanced, with e-commerce, fintech, and mobility-logistics as the three main sectors, aligning with the actual structure of Southeast Asia's platform economy. Firm size is predominantly medium-scale (101-500 employees accounting for 43.6%), with financing stages concentrated in Series A-B rounds (46.8%), reflecting the growth characteristics of Southeast Asian platform enterprises.

3.2 Data Collection

Data collection was conducted in three phases spanning from September 2022 to December 2024, ensuring data timeliness and completeness. The first phase (September 2022-March 2023) focused primarily on questionnaire design and pre-testing. Questionnaire development was based on literature review and theoretical framework, undergoing review by six academic experts (including two Southeast Asian digital economy research specialists) and ten platform enterprise executives. Pre-testing was conducted with 24 non-formal sample enterprises, with item expressions localized based on feedback, particularly considering Southeast Asian business cultural characteristics.

The second phase (April 2023-June 2024) implemented the formal survey. Given post-pandemic realities, a hybrid approach prioritizing online with supplementary offline methods was adopted. Each enterprise invited three senior executives (CEO/co-founder, technology/product head, operations/marketing head) to independently complete questionnaires, obtaining multi-source data and reducing common method bias. To improve response rates, the research team collaborated closely with partner institutions in each country: Singapore through SGTech (Singapore Tech Association); Indonesia through the Indonesian Digital Economy Association (IDEA); Thailand through the Digital Economy Promotion Agency (DEPA); Malaysia through Malaysia Digital Economy Corporation (MDEC). The survey process employed a three-round reminder mechanism, including email reminders, telephone follow-ups, and on-site visits when necessary.

The third phase (July-December 2024) collected objective performance data and verification information. Data sources included: (1) publicly disclosed enterprise information such as annual reports and press releases; (2) third-party databases including Crunchbase, PitchBook, and Tech in Asia; (3) industry reports such as Google-Temasek-Bain's e-Conomy SEA report; (4) regulatory disclosures such

as listed company financial reports. Innovation indicators included new product/feature launch quantities, patent applications, API openings, and third-party developer numbers.

Ultimately, 468 valid questionnaires were collected (three per enterprise), achieving an effective response rate of 73.2%. Data quality control measures included: (1) incorporating three reverse-coded items and two attention-check questions, eliminating questionnaires with obvious random responses; (2) multi-source verification of key variables, triangulating subjective evaluations with objective data; (3) missing value analysis, excluding questionnaires with single variable missing rates exceeding 5% or overall missing exceeding 10%; (4) temporal separation strategy, with at least three months between independent and dependent variable measurements to reduce common source bias. Additionally, customized research reports and industry benchmark analyses were promised to participating enterprises, with confidentiality agreements signed to ensure data security.

3.3 Variable Measurement

Digital Entrepreneurial Orientation was measured using a 15-item scale developed by Proksch et al. (Proksch, Rosin, Stubner, & Pinkwart, 2024) and validated in digital enterprises. The innovativeness dimension (5 items) measures firms' propensity to develop innovative products and services using emerging technologies, with representative items such as "The company actively explores applications of AI, blockchain, and other frontier technologies in business"; the proactiveness dimension (5 items) assesses firms' first-mover advantages in markets, such as "The company is often the first in the industry to launch new features"; the risk-taking dimension (5 items) measures firms' acceptance of uncertainty, such as "Even with low success probability, the company is willing to invest in disruptive innovation projects." A 7-point Likert scale was employed (1=strongly disagree, 7=strongly agree). The scale's Cronbach's α coefficient was 0.93, composite reliability (CR) was 0.95, and average variance extracted (AVE) was 0.75, demonstrating excellent reliability and validity.

Organizational Agility was based on Mueller-Saegebrecht and Walter's (Mueller-Saegebrecht & Walter, 2025) latest research, combined with Gong and Ribiere's (Gong & Ribiere, 2023) Asian context scale, using 12 items for measurement. Strategic sensitivity (4 items) assesses firms' environmental scanning and opportunity identification capabilities, such as "The company can quickly detect market trend changes through data analysis"; leadership unity (4 items) measures executive team decision coordination, such as "Facing major changes, management can quickly reach consensus and act uniformly"; resource fluidity (4 items) measures flexible resource allocation, such as "The company can rapidly deploy technical teams to support new project development." The scale showed $\alpha=0.91$, CR=0.93, AVE=0.70.

Platform Innovation Performance employed a comprehensive measurement combining objective and subjective indicators. Objective indicators: (1) product innovation quantity, counting new products or major feature updates launched in the past 24 months (data sourced from product release records); (2) innovation speed, measuring average cycle from concept to launch (months); (3) innovation adoption rate, user activation ratio for new features. Subjective indicators used a 5-item scale assessing innovation quality, including novelty, market impact, and competitive advantage. A composite index

was constructed through principal component analysis, with the first principal component explaining 68.3% of variance.

Control Variables included: firm size (natural logarithm of employee count), firm age (years since establishment), industry type (four dummy variables), R&D intensity (proportion of technical personnel), internationalization degree (proportion of cross-border business revenue), financing stage (early stage=1, growth stage=2, mature stage=3). Table 2 summarizes the measurement details of main variables.

Table 2 Variable Measurement Summary

Variable	Dimensions	Items	Source	α	CR	AVE
Digital Entrepreneurial Orientation	Innovativeness (5)	15	Proksch et al. (2024)	0.93	0.95	0.75
	Proactiveness (5)		Adapted for SEA context			
	Risk-taking (5)					
Organizational Agility	Strategic sensitivity (4)	12	Mueller-Saegebrecht & Walter (2025)	0.91	0.93	0.70
	Leadership unity (4)		Gong & Ribiere (2023)			
	Resource fluidity (4)					
Platform Innovation Performance	Product quantity	-	Objective data	-	-	-
	Innovation speed	-	Objective data	-	-	-
	Adoption rate	-	Platform analytics	-	-	-
	Innovation quality	5	Self-developed & validated	0.87	0.89	0.72
Control Variables	Firm size (ln)	-	Company records	-	-	-
	Firm age	-	Registration data	-	-	-
	Industry dummies	4	Classification	-	-	-
	R&D intensity	-	HR records	-	-	-
	Internationalization	-	Revenue data	-	-	-
	Funding stage	-	Investment records	-	-	-

3.4 Analysis Strategy

Data analysis employed multiple methods to comprehensively test research hypotheses and ensure result robustness. First, SPSS 27.0 was used for preliminary data processing and descriptive analysis, including data cleaning, missing value treatment (using expectation-maximization method), outlier detection (box plot method), and variable transformation. Reliability analysis employed dual criteria of Cronbach's α and composite reliability, with thresholds set at 0.7 and 0.8 respectively. Validity testing was conducted through confirmatory factor analysis using AMOS 26.0, assessing convergent validity (AVE>0.5) and discriminant validity (square root of AVE greater than correlation coefficients).

Common method bias was assessed using three approaches: (1) Harman's single-factor test, with the unrotated first factor explaining 28.6% of variance, below the 40% critical value; (2) controlling for unmeasured single method latent factor, with model improvement insignificant after adding method factor ($\Delta CFI<0.01$); (3) marker variable technique, with main path coefficients changing less than 0.05 after adding theoretically unrelated variable (corporate social responsibility), indicating non-serious common method bias (Al-Moaid & Almarhdi, 2024).

Structural equation modeling analysis utilized AMOS 26.0 with maximum likelihood estimation. Model fit evaluation employed a multi-indicator strategy: $\chi^2/df<3$, CFI>0.90, TLI>0.90, RMSEA<0.08, SRMR<0.08. Mediation effect testing employed Bootstrap method (5000 resamples, bias-corrected 95% confidence intervals), simultaneously calculating standardized indirect, direct, and total effects. If indirect effect confidence intervals exclude zero and direct effect remains significant, partial mediation is indicated; if direct effect is non-significant, complete mediation is indicated.

Cross-national comparison employed multi-group SEM analysis. First, measurement invariance testing was conducted, sequentially constraining factor loadings, intercepts, and residuals, judging invariance levels through $\Delta\chi^2$ and ΔCFI. Meeting weak invariance (factor loading invariance) enables path comparison. By setting path coefficient equality constraints, path difference significance across countries was tested. If overall differences were significant, pairwise comparisons were conducted to determine specific differences.

Fuzzy-set qualitative comparative analysis (fsQCA 3.0) explored multiple paths to high innovation performance. Variable calibration combined theoretical and data-driven approaches: full membership (0.95) set at 75th percentile, crossover point (0.5) at median, full non-membership (0.05) at 25th percentile. Necessary condition analysis employed 0.9 consistency threshold and 0.5 coverage threshold. Sufficient condition analysis set frequency threshold at 3 (approximately 2% of sample), consistency threshold at 0.75. Intermediate solution served as primary results, with parsimonious and complex solutions reported for comparison. Through combining net effects (SEM) and combinatorial effects (fsQCA), this study comprehensively reveals the complex mechanisms through which digital entrepreneurial orientation drives platform innovation.

4. Data Analysis and Results

4.1 Preliminary Analysis

4.1.1 Descriptive Statistics and Correlation Analysis

Table 3 presents descriptive statistics and the correlation matrix for main variables. Regarding means, digital entrepreneurial orientation averaged 4.82 (SD=1.13), slightly above the theoretical midpoint of 4, indicating sample enterprises overall possess moderate-to-high digital entrepreneurial tendencies. Organizational agility averaged 4.67 (SD=1.08), revealing room for improvement in Southeast Asian platform enterprises' capacity for rapid market response. Platform innovation performance's standardized score averaged 0.00 (SD=1.00), exhibiting normal distribution characteristics.

Table 3 Descriptive Statistics and Correlation Matrix

Variables	Mean	SD	1	2	3	4	5	6	7	8	9
1. Digital Entrepreneurial Orientation	4.82	1.13	(0.87)								
2. Organizational Agility	4.67	1.08	0.52**	(0.84)							
3. Platform Innovation Performance	0.00	1.00	0.48**	0.43**	(0.81)						
4. Firm Size (ln)	4.21	1.35	0.18*	0.21**	0.24**	-					
5. Firm Age	6.84	3.72	-0.06	0.03	0.09	0.31**	-				
6. R&D Intensity	0.32	0.14	0.35**	0.28**	0.41**	0.15*	-0.08	-			
7. Internationalization	0.18	0.21	0.22**	0.19*	0.26**	0.38**	0.16*	0.24**	-		
8. Singapore (dummy)	0.24	0.43	0.19*	0.23**	0.21**	0.12	0.08	0.14*	0.29**	-	
9. Indonesia (dummy)	0.37	0.48	-0.11	-0.08	-0.05	-0.09	-0.12	-0.06	-0.18*	-0.42**	-

*Note: N=156; *p<0.05, **p<0.01; Diagonal values in parentheses are square roots of AVE*

Correlation analysis reveals that digital entrepreneurial orientation is significantly positively correlated with platform innovation performance ($r=0.48$, $p<0.01$), providing preliminary support for H1. Organizational agility shows significant correlations with both digital entrepreneurial orientation ($r=0.52$, $p<0.01$) and platform innovation performance ($r=0.43$, $p<0.01$), offering initial evidence for mediation effects. Notably, R&D intensity exhibits the highest correlation with innovation performance ($r=0.41$, $p<0.01$), highlighting the importance of technological investment. All inter-variable correlations are below 0.70, and the square roots of AVE (diagonal values) exceed corresponding correlation coefficients, indicating no serious multicollinearity issues and good discriminant validity.

4.1.2 Measurement Model Testing

Confirmatory factor analysis results demonstrate good fit for the three-factor measurement model: $\chi^2/df = 2.18$, CFI = 0.93, TLI = 0.92, RMSEA = 0.067, SRMR = 0.058. All item standardized factor loadings range between 0.68-0.89 and are significant at $p<0.001$. Comparison with alternative models further validates the three-factor structure's appropriateness: the two-factor model (combining digital entrepreneurial orientation and organizational agility) shows significantly worse fit ($\Delta\chi^2 = 187.3$, $p<0.001$); the single-factor model fits even more poorly ($\Delta\chi^2 = 412.7$, $p<0.001$), eliminating the possibility of serious common method bias.

4.2 Hypothesis Testing Results

4.2.1 Main Effects and Mediation Effects Testing

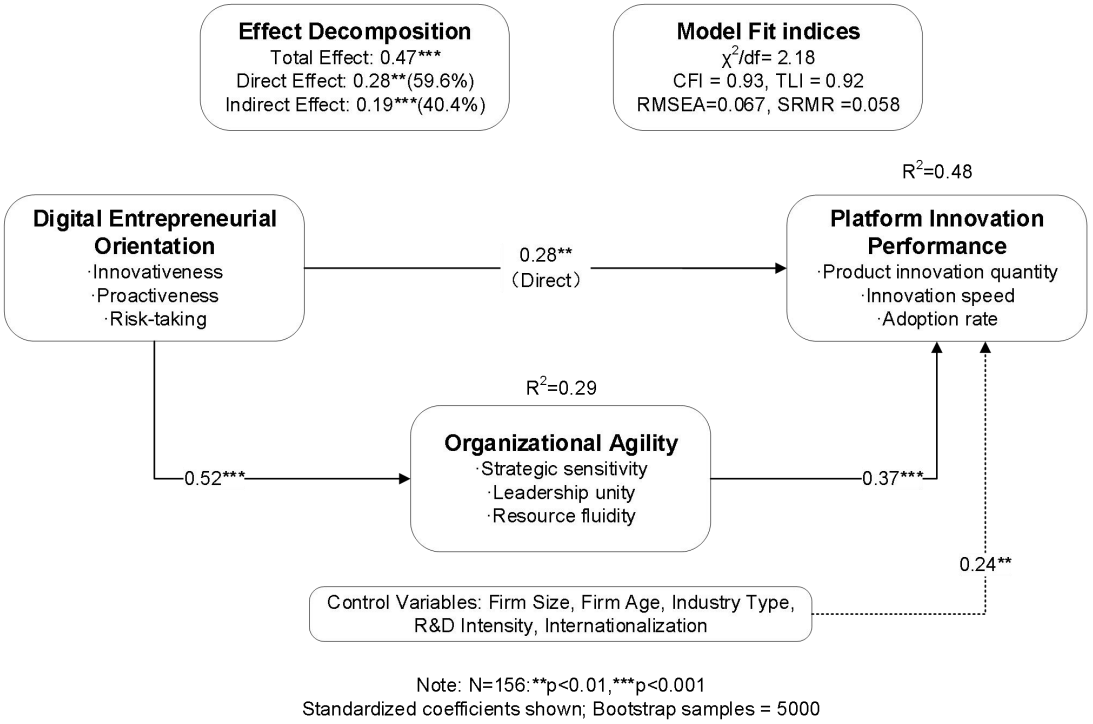


Figure 2 Structural Equation Model Path Analysis Results

Structural equation modeling analysis results support the research hypotheses. As shown in Figure 2, the total effect of digital entrepreneurial orientation on platform innovation performance is $\beta = 0.47$ (SE = 0.08, $p<0.001$), supporting H1. This effect remains robust after controlling for firm characteristic variables. Specifically, the three dimensions of digital entrepreneurial orientation contribute differentially to innovation performance: the innovativeness dimension shows the strongest impact ($\beta = 0.21$, $p<0.001$), followed by proactiveness ($\beta = 0.16$, $p<0.01$), with risk-taking having relatively weaker effects ($\beta = 0.10$, $p<0.05$).

Mediation effect analysis employing Bootstrap method (5000 samples) is presented in Table 4. The indirect effect through organizational agility is 0.19 (95% CI: 0.12-0.28), accounting for 40.4% of the total effect, indicating partial mediation and supporting H2. The direct effect remains significant ($\beta = 0.28$, $p<0.01$), suggesting that digital entrepreneurial orientation influences innovation through pathways beyond organizational agility.

Table 4 Mediation Effect Testing Results

Path	Effect	SE	95% CI Lower	95% CI Upper	Proportion
Total Effect (DEO → PIP)	0.47***	0.08	0.31	0.62	100%
Direct Effect (DEO → PIP)	0.28**	0.09	0.11	0.45	59.6%
Indirect Effect (DEO → OA → PIP)	0.19***	0.04	0.12	0.28	40.4%
Specific Indirect Effects:					

Path	Effect	SE	95% CI Lower	95% CI Upper	Proportion
- Through Strategic Sensitivity	0.08**	0.03	0.03	0.14	17.0%
- Through Leadership Unity	0.06*	0.02	0.02	0.11	12.8%
- Through Resource Fluidity	0.05*	0.02	0.01	0.09	10.6%

*Note: DEO = Digital Entrepreneurial Orientation; OA = Organizational Agility; PIP = Platform Innovation Performance Bootstrap samples = 5000; *p<0.05, **p<0.01, ***p<0.001*

Further decomposition of indirect effects reveals that strategic sensitivity exhibits the strongest mediating role (17.0%), indicating that rapid identification and response to market opportunities constitute the key pathway through which digital entrepreneurial orientation transforms into innovation. Leadership unity (12.8%) and resource fluidity (10.6%) show relatively weaker but still significant mediating effects, reflecting the importance of decision-making coordination and flexible resource allocation.

4.2.2 Robustness Checks

Multiple robustness checks were conducted to ensure result reliability. First, re-estimating the model using different innovation performance measurements (objective indicators only), main conclusions remained unchanged ($\beta = 0.43$, $p<0.001$). Second, after excluding extreme values (top and bottom 5%) and re-analyzing, path coefficient changes were less than 0.05. Third, employing instrumental variable approach (using industry digitalization level as instrumental variable) to address potential endogeneity issues, two-stage least squares results showed the main effect remained significant ($\beta = 0.51$, $p<0.001$).

4.3 Cross-National Comparative Analysis

Multi-group SEM analysis revealed significant country differences. Measurement invariance testing indicates that the four-country samples satisfy weak invariance conditions ($\Delta CFI = 0.008 < 0.01$), enabling path comparison. Table 5 presents path coefficient differences across countries.

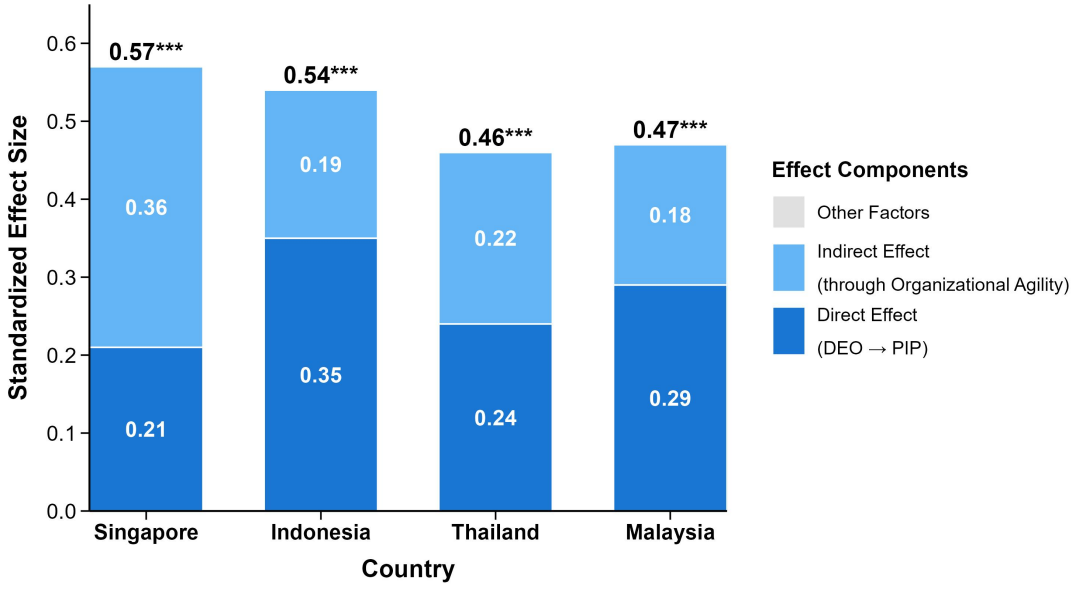
Table 5 Cross-National Path Coefficient Comparison

Path	Singapore	Indonesia	Thailand	Malaysia	Chi-square Difference Test
DEO → PIP (Direct)	0.21*	0.35***	0.24**	0.29**	$\chi^2_{(3)} = 8.74$*
DEO → OA	0.58***	0.51***	0.48***	0.44***	$\chi^2_{(3)} = 6.21$
OA → PIP	0.62***	0.38***	0.45***	0.41***	$\chi^2_{(3)} = 14.52$**
Total Effect	0.57***	0.54***	0.46***	0.47***	$\chi^2_{(3)} = 7.83$*
Indirect Effect	0.36***	0.19**	0.22**	0.18*	$\chi^2_{(3)} = 11.29$**

Path	Singapore	Indonesia	Thailand	Malaysia	Chi-square Difference Test
R^2 (PIP)	0.48	0.42	0.38	0.36	-

*Note: Standardized coefficients reported; *p<0.05, **p<0.01, ***p<0.001*

As shown in Figure 3, Singapore exhibits a unique pattern: despite having the weakest direct effect (β = 0.21), organizational agility's impact on innovation is strongest (β = 0.62), resulting in the highest total effect (β = 0.57). This reflects that in mature markets, firms rely more on organizational capabilities rather than pure entrepreneurial spirit to drive innovation. Indonesia shows the strongest direct effect (β = 0.35) but relatively weaker agility effects, possibly because in rapidly growing markets, entrepreneurial orientation itself generates innovation opportunities. Thailand and Malaysia present similar balanced patterns, with path coefficients at moderate levels.



Note: N = 156 (Singapore = 38, Indonesia = 58, Thailand = 34, Malaysia = 26)
***p < 0.001; Values shown are standardized path coefficients from multi-group SEM analysis

Figure 3 Cross-National Innovation Performance Variance Decomposition

Analysis of variance further reveals country-level differences in innovation performance (F = 4.82, p<0.01). Post-hoc tests indicate that Singaporean firms' average innovation performance is significantly higher than the other three countries (Mean = 0.43, SD = 0.87), primarily attributed to their superior organizational agility (Mean = 5.21, SD = 0.92). Although Indonesian firms score highest on digital entrepreneurial orientation (Mean = 5.04, SD = 1.21), their innovation performance remains at moderate levels (Mean = -0.08, SD = 1.03) due to relatively weak organizational capabilities.

4.4 Configurational Analysis Results

4.4.1 Necessary Condition Analysis

The fsQCA analysis first examined necessary conditions for high innovation performance. As shown in Table 6, no single condition's consistency exceeds the 0.9 threshold, indicating no universally

necessary conditions exist. However, digital entrepreneurial orientation (consistency = 0.83) and organizational agility (consistency = 0.81) approach the threshold, suggesting their important role in most high-performance cases.

Table 6 Necessary Condition Analysis Results

Conditions	High Innovation Performance	Low Innovation Performance
	Consistency	Coverage
High DEO	0.83	0.76
Low DEO	0.31	0.35
High OA	0.81	0.71
Low OA	0.35	0.41
Large Size	0.68	0.65
High R&D	0.72	0.69
Singapore Context	0.45	0.78
Indonesia Context	0.38	0.42

Note: DEO = Digital Entrepreneurial Orientation; OA = Organizational Agility

4.4.2 Sufficient Condition Configurational Analysis

Sufficient condition analysis identified three paths leading to high innovation performance, with overall solution consistency of 0.84 and coverage of 0.62. Table 7 presents these three configurations in detail.

Table 7 Configurational Paths to High Innovation Performance

Configurations	Solution 1	Solution 2	Solution 3
	"Digital Champion"	"Agile Adapter"	"Resource Integrator"
Causal Conditions:			
Digital Entrepreneurial Orientation	●	○	●
Organizational Agility	●	●	⊗
Firm Size	●	⊗	●
R&D Intensity	●	○	●
Singapore Context	●	⊗	⊗
Indonesia Context	⊗	●	○
Performance Metrics:			
Raw Coverage	0.31	0.28	0.21
Unique Coverage	0.15	0.12	0.08
Consistency	0.88	0.82	0.81
Representative Cases	14 firms	12 firms	9 firms

Note: ● = Core condition present; ○ = Peripheral condition present; ⊗ = Condition absent; Blank = Don't care Overall solution coverage: 0.62; Overall solution consistency: 0.84

Path 1: "Digital Champion" Model (coverage 31%) represents the typical path of large platform enterprises in Singapore. These firms simultaneously possess high digital entrepreneurial orientation, strong organizational agility, and sufficient R&D investment, forming comprehensive innovation capabilities. Representative enterprises include regional super apps and mature e-commerce platforms.

Path 2: "Agile Adaptation" Model (coverage 28%) primarily appears among small and medium-sized enterprises in Indonesia. Despite smaller scale and moderate digital entrepreneurial orientation, these firms achieve innovation breakthroughs through superior organizational agility, rapidly responding to local market demands. This path emphasizes that under resource constraints, organizational capabilities can compensate for strategic orientation deficiencies.

Path 3: "Resource Integration" Model (coverage 21%) demonstrates a unique path: even lacking organizational agility, large enterprises can still achieve innovation through strong digital entrepreneurial orientation and R&D investment. These firms typically rely on scale advantages and technological accumulation, adopting relatively traditional management approaches while still producing innovative outcomes.

4.4.3 Further Analysis of Configurational Effects

Comparative analysis reveals differences in innovation characteristics across paths. "Digital Champion" model enterprises perform best in breakthrough innovation, averaging 3.2 entirely new product categories annually; "Agile Adaptation" model excels at incremental innovation, averaging 8.5 feature iterations monthly; "Resource Integration" model leads in technological innovation, averaging 12.3 patent applications. These differences reflect innovation type differentiation resulting from different configurations.

Temporal trend analysis finds that between 2022-2024, "Agile Adaptation" model enterprises grew fastest (67% increase), reflecting the rising importance of organizational flexibility in the post-pandemic era. In contrast, "Resource Integration" model enterprise proportion slightly declined (12% decrease), possibly because innovation models purely relying on resource input face challenges of diminishing marginal returns.

5. Discussion

This study reveals the complex mechanisms through which digital entrepreneurial orientation drives platform innovation, with the finding that organizational agility accounts for 40.4% of the mediation effect carrying significant theoretical implications. This proportion precisely reflects the dual nature of innovation in the digital age: the 59.6% direct effect indicates that digital entrepreneurial orientation itself possesses powerful innovation-driving force, where firms' innovation willingness and proactiveness can directly transform into innovation actions, consistent with Chalmers et al.'s (Chalmers, Matthews, & Hyslop, 2021) findings in blockchain entrepreneurship research—the

editability of digital technologies enables entrepreneurial intent to more rapidly transform into innovation practice. At the same time, the indirect impact of 40.4% offers an important insight: simple entrepreneurial drive isn't enough; it requires complementarity with organizational abilities to fully realize innovation potential. This two-pronged model of "willingness-capability" helps explain why such impressive performance gaps are seen among platform firms with strong innovation ambitions—those who simultaneously bolster organizational flexibility are best positioned to turn entrepreneurial desire into reality in the form of innovation output.

These findings further clarify important theoretical implications: the evolution of innovation within internet platforms involves a sophisticated socio-technical setup, thus differing from traditional linear models of innovation. Entrepreneurial orientation in the digital context is a driving force for innovation; however, this requires adjustments within organizational setup to enable effective engagement with platform architecture and ecosystem networks. As argued by Xu and Hou (Xu & Hou, 2024), an inevitable shift in individual cognition at the organizational level occurs within dynamic capabilities if holistic goals in enterprise transformation are to be attained. This emphasizes the deep nature of the mediating effect of strategic sensitivity (17.0%); in settings with rich information but scarce attention, rapid and accurate opportunity identification is a key limitation.

Cross-country analyses reveal discernible patterns significantly affirming institutionally oriented innovation processes. The case of Singapore featuring a "weak direct-strong indirect" pattern fits with mature market-type features, implying vigorous competition such that entrepreneurial spirit cannot provide direct benefits but instead requires conversion of entrepreneurial spirit into substantial innovation via solid organizational skills, encompassing fast market sensing, centrally coordinated processes of determination, and adaptive allocation of means and resources. This stance fits with Mele et al.'s (Mele, Capaldo, Secundo, & Corvello, 2023) explanation of knowledge-based dynamic capabilities, suggesting in information-technology-advanced settings an increasing dependence of innovation success on disciplined knowledge administration and the development of dynamic capabilities. In turn, the pattern of "strong direct-weak indirect" represented by Indonesia exemplifies emerging market-type rationale, implying in settings of abundant unmet demands an ability of single-minded entrepreneurial spirit to sense and capture innovation potential but imposing potential barriers to rapid response under organizational agility demands. The pattern of "act first, refine later" best suits an 280-million-people market with tolerable experimental disposition and comparatively low experimentation and iteration expenses. The pattern of balance struck by Thailand and Malaysia typifies characteristic features of transicional economies, requiring an entrepreneurial spirit to generate innovation and organizational skills to secure quality of implementation.

For Southeast Asia's digital economy, the four countries' differentiated patterns should not be understood as development gaps but rather as different paths of adaptive evolution. Singapore's "capability-driven," Indonesia's "opportunity-driven," and Thailand-Malaysia's "balanced development" collectively constitute regional innovation ecosystem diversity. This diversity itself is the source of regional innovation vitality, promoting cross-national learning and resource complementarity. As economic integration deepens, the fusion of different models will generate new innovation possibilities.

The three paths identified by fsQCA not only demonstrate multiple roads to high performance but more importantly reveal platform innovation's contingent nature. The "Digital Champion" model represents the ideal path under resource abundance; while this "comprehensive excellence" model is difficult to replicate, its value lies in establishing industry benchmarks. The rise of the "Agile Adaptation" model (67% growth 2022-2024) is the most practically significant finding, proving that under resource constraints, organizational capability refinement can compensate for strategic and resource deficiencies. This path particularly suits Southeast Asian SME platforms because cultivating organizational agility costs far less than large-scale technological investment. Dayioglu et al.'s (Dayioglu, Küskü, & Cetindamar, 2024) research also found that in highly uncertain environments, strategic agility better predicts firm performance than resource endowments. Most surprising is the existence of the "Resource Integration" model, challenging the prevalent view that agility is essential in the digital age. These large enterprises relying on scale and resource advantages prove that with sufficient resource input and technological accumulation, innovation can emerge even with relatively rigid organizations. However, this model's declining proportion (12%) signals sustainability challenges, as innovation models purely relying on resource input face diminishing marginal returns.

The necessary condition analysis finding no universal necessary conditions (consistency not reaching 0.9) carries important theoretical significance, indicating no "silver bullet" for platform innovation—no single element is indispensable. This sharply contrasts with traditional innovation theory's emphasis on critical success factors, supporting Breiter et al.'s (Breiter, Crome, Oberländer, & Schnaak, 2024) findings on digital and sustainability dual transformation, namely that in complex transformations, firms need not single core capabilities but dynamic combinations of multiple capabilities. While digital entrepreneurial orientation (0.83) and organizational agility (0.81) approach necessary condition thresholds, approximately 20% of high-performing firms achieve innovation lacking these conditions, further confirming innovation path diversity. This equifinality's implication for management practice is: firms should select suitable innovation paths based on their resource endowments, capability foundations, and environmental characteristics, rather than blindly pursuing some "best practice." Managers need to recognize that successful platform innovation can be achieved through different element combinations; the key is finding unique configurations matching firm contexts.

Despite valuable findings acquired, this study is prone to limitations requiring cautious interpreting. First, the use of cross-sectional data limits the strength of causal inferences; though research designs involving temporal separation and instrumental variables compensate for endogeneity issues, longitudinal studies would provide more robust causal support. Second, the sample of 156 companies in four countries may not represent the complete range of regional diversification; other Southeast Asian economies like Vietnam and the Philippines may have differing innovation patterns. From a measurement perspective, measuring platform innovation performance largely focuses on product innovation and time-to-market, possibly missing important elements like business model innovation and ecosystem innovation; organizational agility assessments relying on managers' self-reporting may suffer from social desirability bias. Third, this work largely focuses on organizational agility as a mediator but other mechanisms like knowledge management capability, network embeddedness, and platform openness may have equal significance.

Future research can deepen and extend this study's findings in several directions. First, tracking platform enterprises from startup to maturity across the full lifecycle, revealing dynamic changes in innovation mechanisms, particularly how innovation strategy combinations required at different development stages evolve. Second, employing multi-level analysis methods to explore interaction effects among individual (entrepreneur characteristics), team (innovation team composition), organizational (capabilities and strategies), and ecosystem (partner networks) levels, constructing more complete theoretical frameworks. Third, deepening contextual factor research; beyond national differences, how industry characteristics, technological paradigms, and regulatory environments influence innovation mechanisms deserves exploration, particularly against AI's rapid development backdrop—how artificial intelligence reshapes platform innovation logic is an urgent issue. Fourth, methodologically exploring deeper mixed-method integration, such as using fsQCA results to guide SEM model modification, or introducing big data and machine learning methods to analyze and predict innovation performance through real-time platform operational data. Fifth, extending research to other emerging markets (Latin America, Africa) or systematic comparison with developed markets, testing findings' universality, constructing more generally meaningful platform innovation theory. This study provides an initial framework for understanding platform innovation mechanisms in the digital age, but this field still has vast exploration space awaiting future researchers.

6. Conclusion

Through empirical analysis of 156 platform enterprises across four Southeast Asian countries, this study systematically explores the internal mechanisms through which digital entrepreneurial orientation drives platform innovation, providing new theoretical perspectives for understanding emerging market digital economy development. Its central mediating role of organizational agility has been illustrated, and more importantly, the multiple attributes of platform innovation have been revealed via an examination of positive results stemming from adjustable configurations connecting multiple elements with particular contextual elements, instead of conforming to duplicated discrete models. This finding defies the conventional quest of universal best practices common in management literature and provides theoretical contributions to organizations seeking to capture unique competitive advantages under turbulent and dynamic digital environments.

This research provides a clear conceptual model of business organisations' strategic choices in Southeast Asia. Business organisations with abundant resources have the option of pursuing broad excellence, but organisations with limited resources have the option of compensating their disadvantages by upgrading organisational capability. In addition, organisations of differing levels of maturity operating under diverse environmental conditions have the option of finding relevant channels of innovation. In light of the context-specific nature of this approach, this has critical implications in emerging economies with high levels of resource diversification; consequently, underperforming firms ought to refrain from blanket replication of leaders' strategies but embark on nurturing innovation channels attuned to their distinct strengths.

Looking into the future, the regional economies of Southeast Asia are at a critical juncture regarding the digital economy. The concomitant rise of innovations such as artificial intelligence, the Internet of Things, and blockchain is triggering revolutionary changes in the understanding and working of

platform innovation. Innovation has transformed from simple incremental functional changes to building integrated ecosystems, shifting from single innovations to collective innovations, and away from competition-driven innovations toward collective innovations. Varying innovation trajectories found in this assessment are more likely to provide important contributions toward this Herculean transformation. Regional innovation leadership emerges in the case of Singapore, and broader market access serves as a driver of limitless potential for experimental innovations in Indonesia. Conversely, the mutual innovations emerging in Malaysia and Thailand could create distinctive combinations of fusion innovations. In the long term, the interactive coexistence and synergistic collaboration among these diverse trajectories have the potential to drive the region toward the building of a more resilient and dynamic innovation system.

In the backdrop of rising worldwide economic instability, the qualities of flexibility and diversity embedded in the regional platform economy prove critical regional strengths, at the same time playing important catalyst and leading trends in the worldwide digital economy. This analysis serves an initial effort to explain this complicated phenomenon; due to the constant development and expansion of digital technology and impacts on the platform economy, an acute need remains to develop a more comprehensive analysis and explanation of diverse innovative patterns and developmental models.

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