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AI-SME Readiness in ASEAN: A Coupling Coordination Analysis of Digital Capacity and Entrepreneurial Support Systems

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Abstract:
Artificial intelligence has become central to enterprise upgrading and regional digital integration, yet its adoption among small and medium-sized enterprises depends on more than digital infrastructure alone. This study assesses AI-SME readiness across ten ASEAN economies by examining the coordination between digital and technology capacity U_1 and SME entrepreneurial support capacity U_2. Using country-level indicators from the SME Policy Index: ASEAN 2024, the study constructs two analytical subsystems and applies a Coupling Coordination Degree Model to identify each economy's readiness position. A support-gap measure $U_1 - U_2$ is further used to distinguish readiness level from readiness balance. The results reveal a clear coordination hierarchy: Singapore and Malaysia occupy the regional frontier, Thailand, Indonesia and the Philippines form a high-coordination group, Brunei Darussalam and Vietnam appear as transitional cases, while Cambodia, Lao People's Democratic Republic (PDR) and Myanmar show weaker subsystem coordination. The support-gap diagnosis further shows that similar readiness levels may conceal different bottlenecks. Some economies require stronger SME support systems, while others require deeper technological absorption among ordinary firms. The study contributes a macro-diagnostic framework for assessing AI-SME readiness and proposes differentiated policy pathways for ASEAN economies.

Keywords: Artificial Intelligence, SME Readiness, Coupling Coordination Degree Model, Digital Transformation, ASEAN, Entrepreneurial Ecosystem

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INTRODUCTION

Artificial intelligence has moved from a frontier technology discussion into the policy language of enterprise upgrading, industrial transformation and regional digital integration. Across ASEAN, this shift is reflected in national AI roadmaps, domestic digital economy strategies and regional frameworks such as the ASEAN Digital Masterplan 2025 and the ASEAN Digital Economy Framework Agreement agenda (ASEAN, 2021, 2023). For small and medium-sized enterprises, these policy developments create expectations that AI can improve productivity, market responsiveness, customer analytics, supply-chain resilience and business decision-making. Yet the movement from digital ambition to small-firm adoption remains uneven. SMEs rarely absorb AI through technology availability alone; adoption requires finance, managerial commitment, skills, data capability, regulatory clarity and market access. AI readiness is therefore better understood as part of a wider digital transformation process, where digital technologies reshape strategy, innovation, governance and organisational value creation rather than merely expanding technical infrastructure (Bharadwaj et al., 2013; Dwivedi et al., 2021; Nambisan et al., 2017; Vial, 2019).

This coordination problem matters because SMEs remain central to employment, entrepreneurship and inclusive growth in ASEAN, while still facing persistent constraints in financing, human capital and technology absorption (Asian Development Bank [ADB], 2024; OECD & ERIA, 2024). SME digitalisation has become a policy priority precisely because digital gaps can widen inequalities across firms, places and workers if smaller enterprises are unable to adopt and use digital tools effectively (OECD, 2021). The *SME policy index: ASEAN 2024* shows that ASEAN economies differ sharply across technology and innovation, access to finance, market access, institutional framework, regulation, education and skills, and inclusive SME support (OECD & ERIA, 2024). Regional digital integration may therefore widen opportunity for some firms while leaving less-supported SMEs at the edge of the transition. Earlier regional discussions have similarly warned that AI readiness gaps may deepen existing digital divides if skills, infrastructure and institutional support remain uneven (Isono & Prilliadi, 2023; Marsan, 2021).

Recent SME-AI studies locate adoption barriers across technological, organisational and environmental layers. In more digitally active ASEAN settings, AI adoption is shaped by technological orientation, organisational readiness, top management commitment, perceived usefulness, knowledge gaps and financial constraints (Boonmee et al., 2025; Enshassi et al., 2025; Jalil et al., 2025; Lada et al., 2023; Verma et al., 2024). Manufacturing-focused evidence further links AI adoption to leadership, skills, organisational behaviour and supply-chain capability, particularly in Vietnam's SME sector (Dey et al., 2024; Roux et al., 2025). In less mature adoption environments, infrastructure limitations, weak digital maturity, funding gaps and insufficient organisational readiness continue to restrict the movement from basic digitalisation to AI use (Maharani, 2023; Quimba et al., 2024; Santosa & Surgawati, 2024). The recurring message is that SME AI adoption is not a single technology decision, but a multi-condition process shaped by the surrounding ecosystem.

A remaining gap lies at the macro-policy level. Existing research tends to examine adoption intention, sector-specific barriers or country-specific firm behaviour, while the broader policy architecture of AI-SME readiness remains less directly examined. Digital readiness, SME support and entrepreneurial ecosystem conditions are often discussed separately, although they are likely to interact. This gap becomes more relevant as ASEAN moves toward deeper digital market integration, where cross-border data governance, digital trade rules and interoperability will increasingly shape the conditions under which SMEs participate in regional value creation (ASEAN, 2023; UNCTAD, 2021). A country may have visible digital policy ambition but insufficient SME finance, skills or regulatory support. Another may have a broad SME support structure but a weaker technology and innovation base. In both cases, the binding constraint is not simply the level of digital development, but the alignment between technological foundations and the support systems through which smaller firms absorb new technologies.

The argument is grounded in three connected bodies of research. The Technology-Organisation-Environment framework treats technology adoption as the outcome of technological conditions, organisational capacity and external support rather than technology availability alone (Tornatzky & Fleischer, 1990; Oliveira & Martins, 2011). Absorptive capacity theory suggests that external knowledge becomes valuable only when actors can recognise, assimilate and apply it (Cohen & Levinthal, 1990; Zahra & George, 2002). Entrepreneurial ecosystem research adds that productive entrepreneurship depends on the interaction of finance, institutions, human capital, markets and support structures (Spigel, 2017; Stam, 2015). Read through these perspectives, SME AI readiness becomes a coordination issue: digital and technology capacity provides the technical foundation, while SME entrepreneurial support capacity determines whether that foundation can be converted into usable business capability.

This study develops a country-level diagnostic assessment of AI-SME readiness across the ten ASEAN economies. Using ASPI 2024 country-level dimension scores, the empirical framework constructs two analytical subsystems. The first subsystem, U_1, captures digital and technology capacity through the productivity, technology and innovation dimension. The second subsystem, U_2, captures SME entrepreneurial support capacity through access to finance, market access and internationalisation, institutional framework, legislation, regulation and tax, entrepreneurial education and skills, and social enterprises and inclusive SMEs. Environmental policies and SMEs are retained as a contextual dimension rather than folded into U_2, since sustainability-oriented SME policy belongs to the wider ecosystem but does not directly measure entrepreneurial support for AI adoption.

Methodologically, the study applies the Coupling Coordination Degree Model (CCDM) to evaluate the alignment between U_1 and U_2. The model maps the structural position of ASEAN economies within a dual-capacity space and identifies subsystem imbalances that may restrict the movement from policy-level AI ambition to firm-level readiness. The support-gap measure $U_1 - U_2$ separates readiness level from readiness balance, allowing the analysis to diagnose whether an economy's main bottleneck lies on the technological side or the SME support side.

The study contributes by reframing ASEAN SME AI readiness as a coordination problem rather than a single digital-capacity ranking. It complements firm-level AI adoption studies by locating enterprise adoption constraints within the policy architecture that shapes systemic absorptive capacity. It also develops differentiated policy implications: high-coordination economies require instruments that deepen firm-level AI usability, transitional economies require ecosystem alignment, and late-developing economies require foundational SME capacity-building before advanced AI adoption programmes can become effective.

The article proceeds by first reviewing the literature on AI readiness, SME support systems and coordination in digital transformation. It then explains the ASPI 2024 data, variable construction, normalisation procedure and CCDM specification. The empirical section presents the coordination ranking, the $U_1 - U_2$ map, the support-gap diagnosis and the dimension-level heatmap. The final section summarises the findings, clarifies the theoretical and methodological contributions, and develops differentiated policy implications for ASEAN.

LITERATURE REVIEW

AI Readiness beyond Digital Infrastructure

AI readiness is often linked to digital infrastructure, national strategies and technology deployment. For SMEs, this interpretation is too narrow. Digital transformation research shows that advanced technologies reshape organisational routines, innovation processes, governance structures and value creation, instead of functioning as isolated technical inputs (Bharadwaj et al., 2013; Nambisan et al., 2017; Vial, 2019). AI deepens this requirement because its use depends on data capability, managerial interpretation, workforce skills and the ability to redesign business processes (Dwivedi et al., 2021).

Recent SME-AI studies support this broader view. Adoption is shaped by organisational readiness, top management commitment, technological orientation, perceived usefulness, implementation cost, knowledge gaps and security concerns (Boonmee et al., 2025; Enshassi et al., 2025; Jalil et al., 2025; Lada et al., 2023; Verma et al., 2024). Studies of manufacturing and emerging-market SMEs further connect AI adoption to leadership, skills, organisational behaviour, infrastructure, funding and supply-chain capability (Dey et al., 2024; Maharani, 2023; Quimba et al., 2024; Roux et al., 2025; Santosa &

Surgawati, 2024). These findings indicate that AI readiness is a multi-condition process, not a simple measure of digital presence.

This reading is consistent with the Technology-Organisation-Environment framework, where adoption depends on technological, organisational and environmental conditions working together (Oliveira & Martins, 2011; Tornatzky & Fleischer, 1990). It is also relevant to ASEAN's regional digital agenda. The ASEAN Digital Masterplan 2025 and the Digital Economy Framework Agreement agenda signal stronger regional integration, but smaller firms can benefit from this agenda only when domestic readiness gaps are addressed (ASEAN, 2021, 2023). Digital infrastructure may create opportunity, but firm-level readiness depends on the conditions that allow SMEs to absorb and use that opportunity.

SME Support Systems as Adoption Infrastructure

SME support systems establish the practical conditions through which digital capacity becomes usable. Access to finance, market access, institutional coordination, regulatory clarity, tax conditions, entrepreneurial education, skills development and inclusion-oriented policies shape whether smaller firms can absorb technological risk and convert digital opportunity into business capability.

Recent AI adoption research repeatedly identifies cost, skills, data security, system integration and organisational readiness as barriers for SMEs (Boonmee et al., 2025; Dey et al., 2024; Enshassi et al., 2025; Quimba et al., 2024; Verma et al., 2024). These barriers are not purely internal weaknesses. They are partly shaped by the surrounding support environment. A firm with limited technical staff may still adopt AI-related tools if training, advisory services, financing schemes and regulatory guidance are accessible. Conversely, national digital strategies may produce limited SME uptake when support systems remain thin.

Entrepreneurial ecosystem research provides the theoretical basis for this argument. Productive entrepreneurship depends on the interaction of institutions, finance, knowledge, human capital, markets and support networks, not isolated firm effort (Spigel, 2017; Stam, 2015). Absorptive capacity theory leads to a similar conclusion: external knowledge becomes valuable only when firms and systems can recognise, assimilate and apply it (Cohen & Levinthal, 1990; Zahra & George, 2002). For SMEs, absorptive capacity is therefore not only an internal managerial trait. It is also supported or restricted by public training, finance, advisory services and regulatory structures.

Policy evidence points in the same direction. The *Asia small and medium-sized enterprise monitor 2024* frames resilient MSME growth as a multidimensional issue involving finance, digitalisation, market access and institutional support (ADB, 2024). The *SME policy index: ASEAN 2024* evaluates SME policy conditions across technology and innovation, finance, market access, institutions, regulation, education and skills, inclusion and environmental policy (OECD & ERIA, 2024). These frameworks suggest that SME AI readiness depends on the relationship between technological capacity and support capacity, not one dimension alone.

Coordination Rather than Isolated Capacity

The recent literature increasingly points to a coordination problem. Advanced AI adoption remains difficult when digital infrastructure develops faster than SME support systems. At the same time, a broad

SME support structure may have limited AI relevance if the technological and innovation base remains shallow. Both cases reflect subsystem mismatch.

This coordination logic fits current debates on regional digital policy. As ASEAN moves toward deeper digital market integration, cross-border data governance, digital trade rules and interoperability will increasingly shape the conditions under which SMEs participate in regional value creation (ASEAN, 2023; UNCTAD, 2021). Yet regional integration may benefit firms unevenly if domestic support systems do not help SMEs meet new digital, regulatory and capability requirements. Recent discussions on emerging technology adoption in Southeast Asian MSMEs similarly suggest that advanced technologies such as AI remain underused compared with basic digital tools because adoption depends on finance, skills, infrastructure and organisational maturity (Chong et al., 2026; Noor et al., 2026).

Readiness should therefore not be assessed only through a single ranking. A high digital score may conceal weak SME support, while a broad SME support structure may have limited AI relevance if the technological base remains shallow. The literature supports a dual-capacity reading of AI-SME readiness: digital and technology capacity captures the technical foundation, while SME entrepreneurial support capacity captures the institutional and practical conditions that allow SMEs to absorb that foundation. The next section translates this theoretical distinction into the empirical framework used in this study.

RESEARCH METHODOLOGY

Data Source and Research Design

Empirical data for this study are drawn from the *SME Policy Index: ASEAN 2024: Enabling Sustainable Growth and Digitalisation*, jointly prepared by the Organisation for Economic Co-operation and Development and the Economic Research Institute for ASEAN and East Asia (OECD & ERIA, 2024). The index provides a comparable policy assessment of SME conditions across ASEAN economies, covering technology, finance, institutions, regulation, skills, market access and inclusion. Unlike broad ICT indicators, ASPI 2024 captures the policy environment surrounding SMEs rather than digital infrastructure alone.

The unit of analysis is the country. The sample includes Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. Since the data are country-level policy scores, the study examines structural AI-SME readiness rather than firm-level AI adoption. This design follows the logic of the Technology-Organisation-Environment framework, where technological adoption is shaped by external policy and institutional conditions as well as internal capability (Tornatzky & Fleischer, 1990). It is also consistent with absorptive capacity theory, which stresses that the value of external knowledge depends on the ability of firms and systems to recognise, assimilate and apply it (Cohen & Levinthal, 1990; Zahra & George, 2002).

Figure 1 presents the methodological framework. The analysis starts from the ASPI 2024 dimensions, reorganises them into two readiness subsystems, applies the coupling coordination degree model and interprets the result as a macro-level diagnosis of AI-SME readiness.

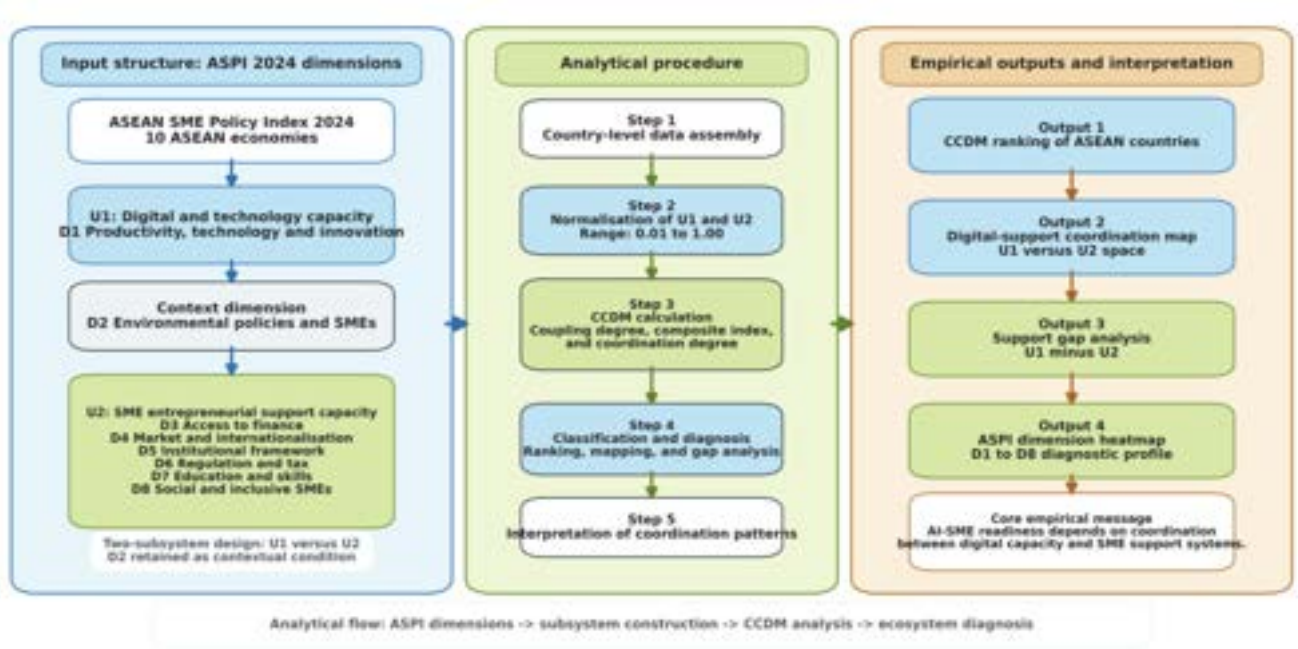

Figure 1: Methodological framework

Variable Construction

The study constructs two analytical subsystems. The first subsystem, U_1, represents digital and technology capacity. It is measured by ASPI Dimension 1, productivity, technology and innovation. This dimension captures the policy foundation for innovation, productivity upgrading and technology-oriented SME development. In this study, U_1 is not treated as direct evidence of AI use, but as the digital and technological base upon which AI-related SME upgrading may depend.

The second subsystem, U_2, represents SME entrepreneurial support capacity. It is calculated as the arithmetic mean of ASPI Dimensions 3 to 8, namely access to finance, market access and internationalisation, institutional framework, legislation, regulation and tax, entrepreneurial education and skills, and social enterprises and inclusive SMEs. These dimensions are grouped because SME technology adoption is rarely driven by technological readiness alone. It also requires finance, skills, regulatory clarity, institutional support and market opportunities. This treatment is aligned with entrepreneurial ecosystem research, which views productive entrepreneurship as the outcome of interacting institutions, resources, knowledge and market conditions rather than isolated firm effort (Spigel, 2017; Stam, 2015).

ASPI Dimension 2, environmental policies and SMEs, is retained as a contextual dimension but excluded from the U_2 calculation. The reason is that Dimension 2 mainly reflects sustainability-oriented SME policy, while U_2 is intended to measure direct entrepreneurial support capacity. Including environmental policy in U_2 would blur the distinction between SME business support and broader sustainability context. Table 1 summarises the construction of the two subsystems and the mapping of ASPI dimensions.

Table 1: Measurement of AI-SME Readiness Constructs

Construct	Symbol	Dimension Included	Role in Analysis	Construction	Source
Digital and Technology Capacity	U_1	D1 Productivity, technology and innovation	Core technology-oriented capacity	Min-max normalised to [0.01, 1.00]	ASPI 2024
Context Dimension	Context	D2 Environmental policies and SMEs	Contextual sustainability condition	Retained for heatmap diagnosis	ASPI 2024
SME Entrepreneurial Support Capacity	U_2	D3 Access to finance; D4 Market access and internationalisation; D5 Institutional framework; D6 Legislation, regulation and tax; D7 Entrepreneurial education and skills; D8 Social and inclusive SMEs	Broader SME support environment	Arithmetic mean of normalised D3–D8 scores	ASPI 2024
Coupling Coordination Degree	D	U_1 and U_2	Final coordination indicator	$\mathrm{D} = \sqrt{\mathrm{C} \times \mathrm{T}}$	Author's calculation
Support Gap	$U_1 - U_2$	U_1 and U_2	Direction of subsystem imbalance	Positive values indicate stronger U_1; negative values indicate stronger U_2	Author's calculation

Note: U_1 captures digital and technology capacity; U_2 captures SME entrepreneurial support capacity. D2 is retained as a contextual dimension and is not included in U_2.

Normalisation and CCDM Specification

The original ASPI scores are reported on a scale from 1 to 6. To ensure comparability between U_1 and U_2, the subsystem scores are normalised before the coupling coordination calculation. Following composite indicator practice, min-max normalisation is applied (OECD & JRC, 2008). The normalised value is calculated as:

$$X_i^* = 0.01 + 0.99 \times \frac{X_i - X_{\min}}{X_{\max} - X_{\min}}$$

where X_i refers to the original subsystem score for the country i, $X_{\min}$ and $X_{\max}$ refer to the minimum and maximum values observed in the ASEAN sample, and X_i^* is the normalised score. The interval is set to $[0.01,1.00]$ instead of $[0,1]$ to avoid a mechanical zero effect in the coupling model when a country is located at the sample minimum.

The coupling degree between U_1 and U_2 is calculated as:

$$C_i = \frac{2\sqrt{U_{1i}U_{2i}}}{U_{1i} + U_{2i}}$$

where C_i measures the balance between digital and technology capacity and SME entrepreneurial support capacity. Since balance alone does not capture the overall development level of the two subsystems, the composite development index is calculated as:

$$T_i = 0.5U_{1i} + 0.5U_{2i}$$

Equal weights are used because the study treats technological capacity and entrepreneurial support capacity as jointly necessary conditions for AI-SME readiness. The final coupling coordination degree is then obtained as:

$$D_i = \sqrt{C_i \times T_i}$$

A higher D indicates stronger coordination between the two subsystems. In this study, the CCDM is used as a macro-diagnostic instrument rather than a causal estimation model. It identifies whether ASEAN economies possess balanced policy foundations for SME AI readiness, with the central premise that digital capacity becomes meaningful for SMEs only when it is matched by entrepreneurial support, institutional readiness and policy coordination.

RESULTS AND DISCUSSION

Baseline ASPI Dimension Profile

The baseline ASPI 2024 configurations in Table 2 reveal a stratified SME policy landscape across ASEAN. The regional divide is not confined to technology and innovation. It also appears across access to finance, market access, institutional framework, regulation, entrepreneurial education and inclusive SME support. AI-SME readiness therefore cannot be reduced to digital infrastructure or national AI ambition alone. In small-firm settings, advanced technology becomes usable only when finance, skills, institutional clarity and market channels are sufficiently in place (Lada et al., 2023; Oliveira & Martins, 2011).

Table 2: ASPI 2024 Dimension Scores of ASEAN Economies

Country	D1 Tech & innovation	D2 Environment	D3 Finance	D4 Market Access	D5 Institutions	D6 Regulation & Tax	D7 Education & Skills	D8 Inclusive SMEs
Singapore	5.8	6.0	5.4	6.0	6.0	5.6	5.6	4.4
Malaysia	5.4	5.8	5.4	5.6	5.8	5.2	5.0	4.6
Thailand	5.1	5.4	5.0	5.5	5.4	4.4	4.8	4.0
Indonesia	4.8	4.8	4.9	5.4	4.9	4.6	5.0	4.2
Philippines	4.6	4.8	4.8	5.2	5.0	4.1	4.6	4.2
Brunei	4.4	4.6	4.6	3.7	4.6	4.0	4.2	3.6
Vietnam	4.2	4.6	4.7	4.6	4.8	3.6	3.2	3.0
Cambodia	3.4	4.2	2.8	3.0	4.4	2.6	3.2	2.6
Lao PDR	3.2	3.8	2.6	2.8	4.0	2.6	2.8	2.6
Myanmar	2.3	2.0	3.8	2.4	2.4	2.3	2.3	2.3

Note: Scores are original ASPI 2024 dimension scores on a 1–6 scale. D1 represents digital and technology capacity; D2 is retained as a contextual dimension; D3–D8 are used to construct SME entrepreneurial support capacity.

Singapore and Malaysia anchor the upper end of the distribution, with comparatively strong scores across most ASPI dimensions. Thailand, Indonesia and the Philippines form a second high-performing group, while Brunei Darussalam and Vietnam occupy a more transitional position. Cambodia, Lao PDR and Myanmar remain weaker across several foundational areas. The pattern reflects a familiar ASEAN problem: regional digital transformation has accelerated, but SME policy capacity remains uneven across member states (ASEAN, 2021; Isono & Prilliadi, 2023; OECD & ERIA, 2024).

The baseline table clarifies the need for a coordination model. A strong digital dimension has limited meaning if smaller firms lack financing, skills or regulatory support. Likewise, a broad SME support system may not translate into AI readiness if the technological and innovation base remains shallow. The ASPI profile supports the central premise of this paper: ASEAN SME AI readiness is best read through the alignment between digital capacity and entrepreneurial support capacity, not through a single-dimensional digital ranking.

Coupling Coordination Hierarchy

The computed coupling coordination degrees in Figure 2 and Table 3 translate the baseline stratification into a clear hierarchy. Singapore stands at the frontier with a coordination score of 1.00, followed by Malaysia at 0.95. Thailand, Indonesia and the Philippines also fall within the high-coordination group, with scores of 0.89, 0.86 and 0.83 respectively. Brunei Darussalam and Viet Nam form the moderate group, while Cambodia and Lao PDR remain in the low-coordination category. Myanmar records the weakest position at 0.17.

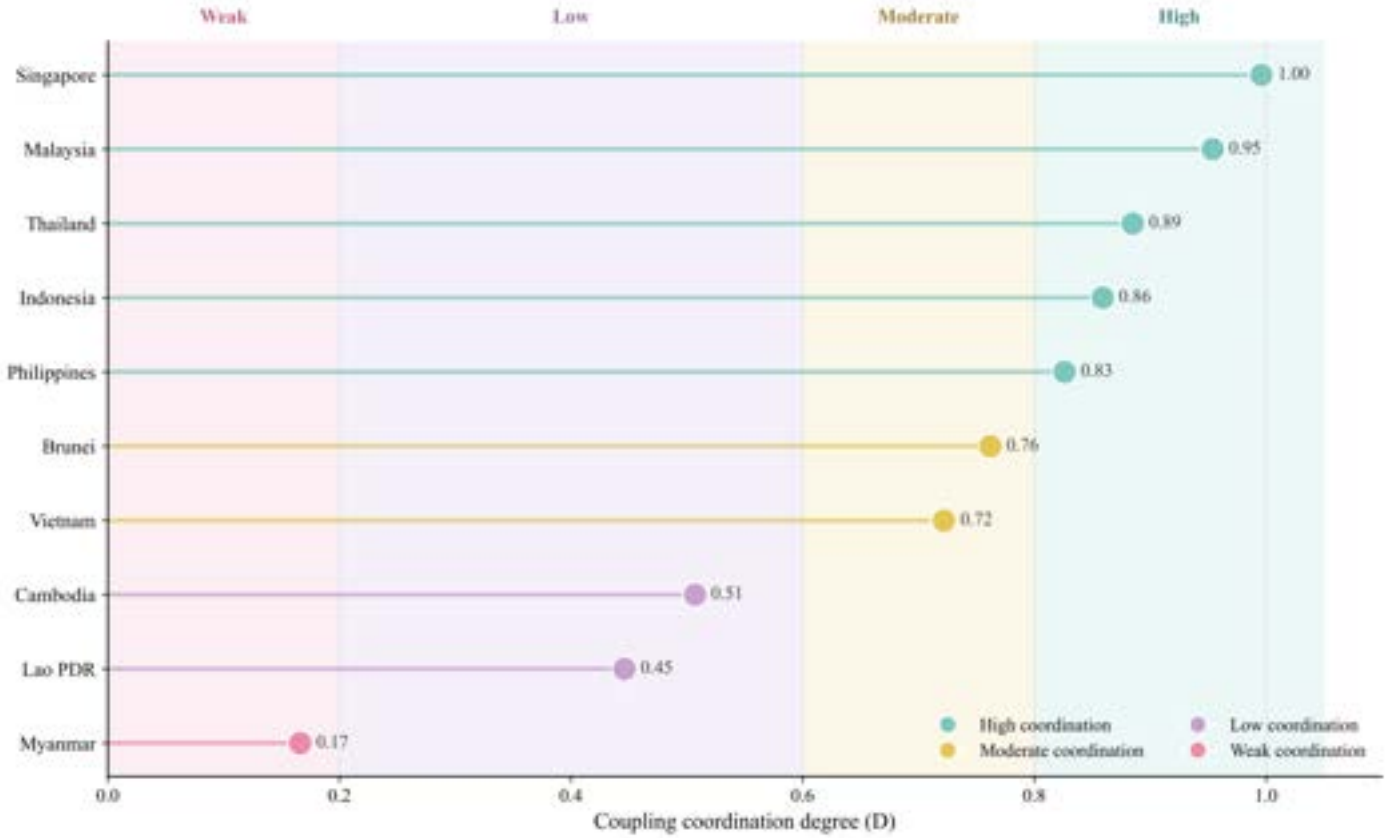

Figure 2: CCDM Ranking of ASEAN Economies
Note: *D* denotes the coupling coordination degree. Values are rounded to two decimal places.

The high-coordination economies do not merely possess stronger digital foundations. Their advantage lies in the closer synchronization between digital and technology capacity and SME support capacity. Recent firm-level evidence from ASEAN continues to show that AI adoption among SMEs is constrained by organisational readiness, managerial commitment, financial capacity, workforce skills and external support, even in countries where digital policy discourse is already active (Boonmee et al., 2025; Dey et al., 2024; Lada et al., 2023; Quimba et al., 2024)

Table 3: Coupling Coordination Results and Support-Gap Classification

Country	U_1 Digital Capacity	U_2 SME Support Capacity	(C)	(T)	(D)	Rank	Coordination Type	Ecosystem Type	Support Gap ($U_1 - U_2$)
Singapore	1.000	0.982	1.000	0.991	0.996	1	High Coordination	AI-ready ecosystem	0.018
Malaysia	0.888	0.931	1.000	0.910	0.954	2	High Coordination	AI-ready ecosystem	-0.042
Thailand	0.791	0.777	1.000	0.784	0.885	3	High Coordination	AI-ready ecosystem	0.014

Country	U_1 Digital Capacity	U_2 SME Support Capacity	(C)	(T)	(D)	Rank	Coordination Type	Ecosystem Type	Support Gap ($U_1 - U_2$)
Indonesia	0.693	0.785	0.998	0.739	0.859	4	High Coordination	AI-ready ecosystem	-0.092
Philippines	0.637	0.729	0.998	0.683	0.826	5	High coordination	AI-ready ecosystem	-0.092
Brunei	0.596	0.566	1.000	0.581	0.762	6	Moderate Coordination	Dual-lagging ecosystem	0.029
Vietnam	0.540	0.505	0.999	0.522	0.722	7	Moderate Coordination	Dual-lagging ecosystem	0.035
Cambodia	0.303	0.218	0.987	0.260	0.507	8	Low Coordination	Dual-lagging ecosystem	0.085
Lao PDR	0.247	0.160	0.977	0.204	0.446	9	Low Coordination	Dual-lagging ecosystem	0.087
Myanmar	0.010	0.077	0.639	0.043	0.166	10	Weak Coordination	Dual-lagging ecosystem	-0.067

Note. C denotes the coupling degree, T denotes the composite development index, and D denotes the coupling coordination degree. The support gap is calculated as $U_1 - U_2$. Positive values indicate that digital capacity exceeds SME support; negative values indicate that SME support exceeds digital capacity.

Malaysia's second-place standing, with $D = 0.95$, reflects a synchronized policy architecture rather than mere developmental ambition. The empirical positioning points to a well-institutionalized SME support network, where the cross-sectoral developmental role of SME Corp. Malaysia complements the digital economy initiatives driven by MDEC. By embedding technological upgrading within broader industrial blueprints, including the National Artificial Intelligence Roadmap 2021–2025 and the New Industrial Master Plan 2030, Malaysia has aligned macro-level digital priorities with enterprise-level support structures (MDEC, n.d.; MITI, 2023; MOSTI, 2021; SME Corp. Malaysia, n.d.). The remaining challenge for the Malaysian ecosystem is not basic institutional capacity building, but deeper technological absorption among conventional, non-frontier SMEs.

The moderate and lower groups show why AI policy cannot be copied mechanically across ASEAN. Viet Nam has growing evidence of AI-related potential in manufacturing and supply chain resilience, yet its national coordination score still indicates incomplete ecosystem alignment (Dey et al., 2024; Roux et al., 2025). Cambodia, Lao PDR and Myanmar face a more basic constraint. Their low scores indicate that digital capacity and SME support capacity are both limited. For these economies, AI adoption programmes risk becoming policy symbolism when they are not preceded by basic improvements in financing, skills, institutional stability and digital infrastructure.

Digital-Support Coordination Map

The $U_1 - U_2$ map in Figure 3 shows that ASEAN economies do not scatter randomly across the policy space. The dominant pattern is a diagonal ladder running from dual-lagging ecosystems to AI-ready ecosystems. Countries with stronger digital and technology capacity generally also possess stronger SME entrepreneurial support capacity. Rather than revealing separate digital-led and support-led worlds, the map suggests that the two subsystems tend to develop together.

The observed diagonal trajectory reinforces the paper's core argument. ASEAN SME AI readiness is less about isolated digital strength than about synchronized ecosystem development. Singapore and Malaysia occupy the upper-right frontier, while Thailand, Indonesia and the Philippines sit close behind. Their advantage lies in coordination, not in the disappearance of adoption barriers. Studies on ASEAN SMEs

still report knowledge gaps, budget constraints, security concerns, system integration problems and uneven organisational readiness (Boonmee et al., 2025; Enshassi et al., 2025; Verma et al., 2024).

At the lower end, Cambodia, Lao PDR and Myanmar represent a dual-capacity problem. Their position is not simply a case of weak technology. It reflects the simultaneous underdevelopment of digital foundations and SME support systems. In such contexts, isolated digital infrastructure or headline AI strategies cannot generate broad SME adoption by themselves. Without basic entrepreneurial support, digital capacity becomes an enclave rather than an ecosystem. A more realistic policy sequence would strengthen SME finance, digital literacy, business advisory services and legal certainty before expecting advanced AI diffusion.

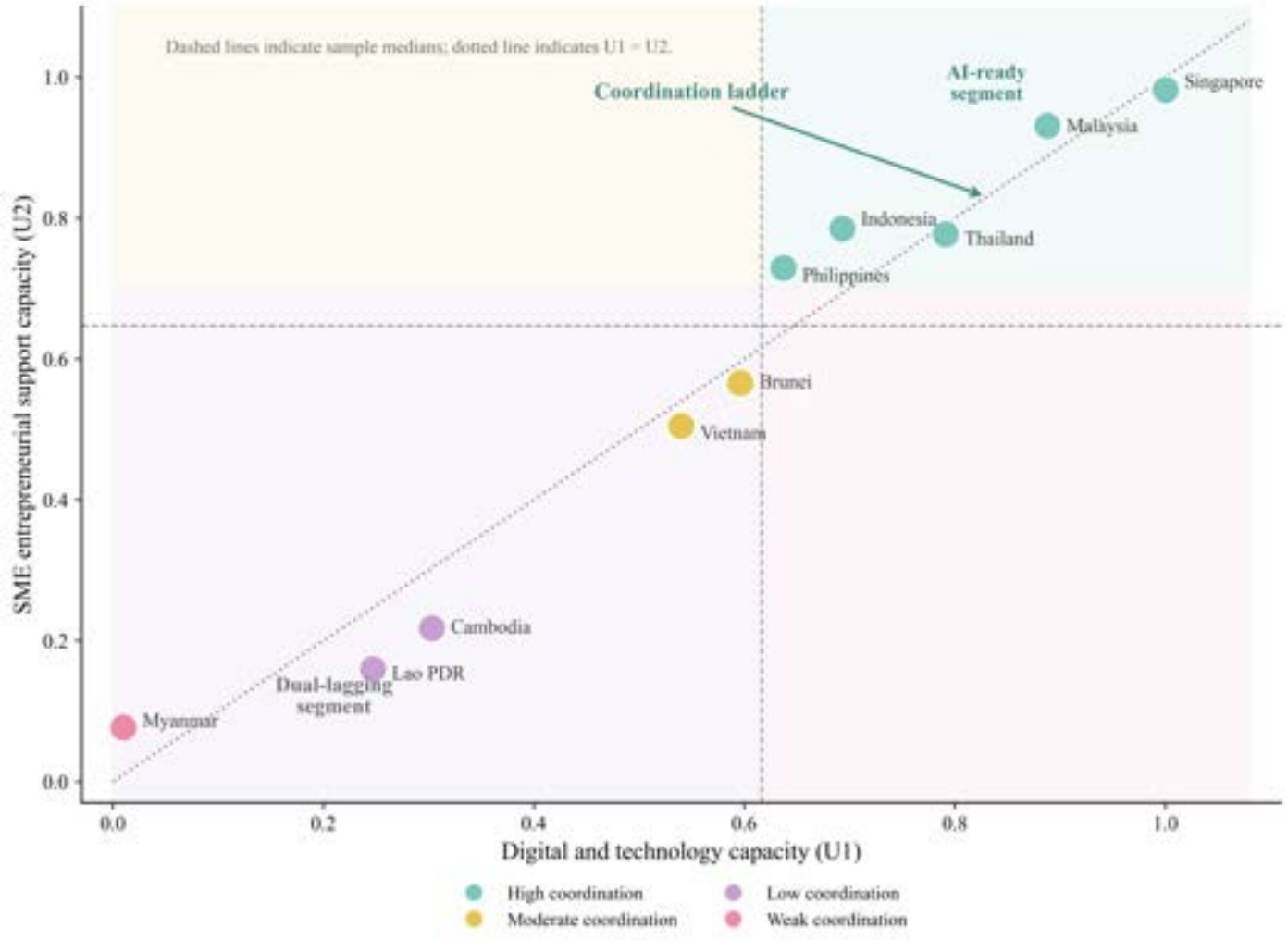

Figure 3: Digital-Support Coordination Map

Support Gap Between Digital Capacity and SME Support

The support gap in Figure 4 isolates the difference between U_1 and U_2. Positive values indicate that digital and technology capacity exceeds SME support capacity, while negative values indicate the opposite. The comparative delta prevents the empirical framework from collapsing into a flattened league table, since countries with similar readiness levels may still face different internal bottlenecks.

Cambodia and Lao PDR exhibit the most pronounced positive gaps, both at 0.09. In these post-frontier contexts, the directional imbalance does not imply technological maturity. It indicates a low-base asymmetry, where foundational SME support systems lag even behind basic digital connectivity. Foreign direct investment, cross-border infrastructure projects or telecommunication corridors may install localized digital enclaves, yet the surrounding entrepreneurial ecosystem often lacks the domestic financial depth and technical training networks needed to internalize those assets. For early-stage systems, top-down AI deployment policies risk becoming institutional symbolism; resource allocation should first prioritize regulatory stabilization, baseline financial inclusion and practical SME capability building.

Vietnam and Brunei Darussalam show smaller positive gaps. Viet Nam's manufacturing base has become increasingly visible in AI and supply-chain studies, but the gap indicates that wider SME support instruments still need to catch up with technological ambition (Dey et al., 2024; Roux et al., 2025). Brunei Darussalam's position reflects a different constraint, linked more closely to the scale and depth of its SME ecosystem.

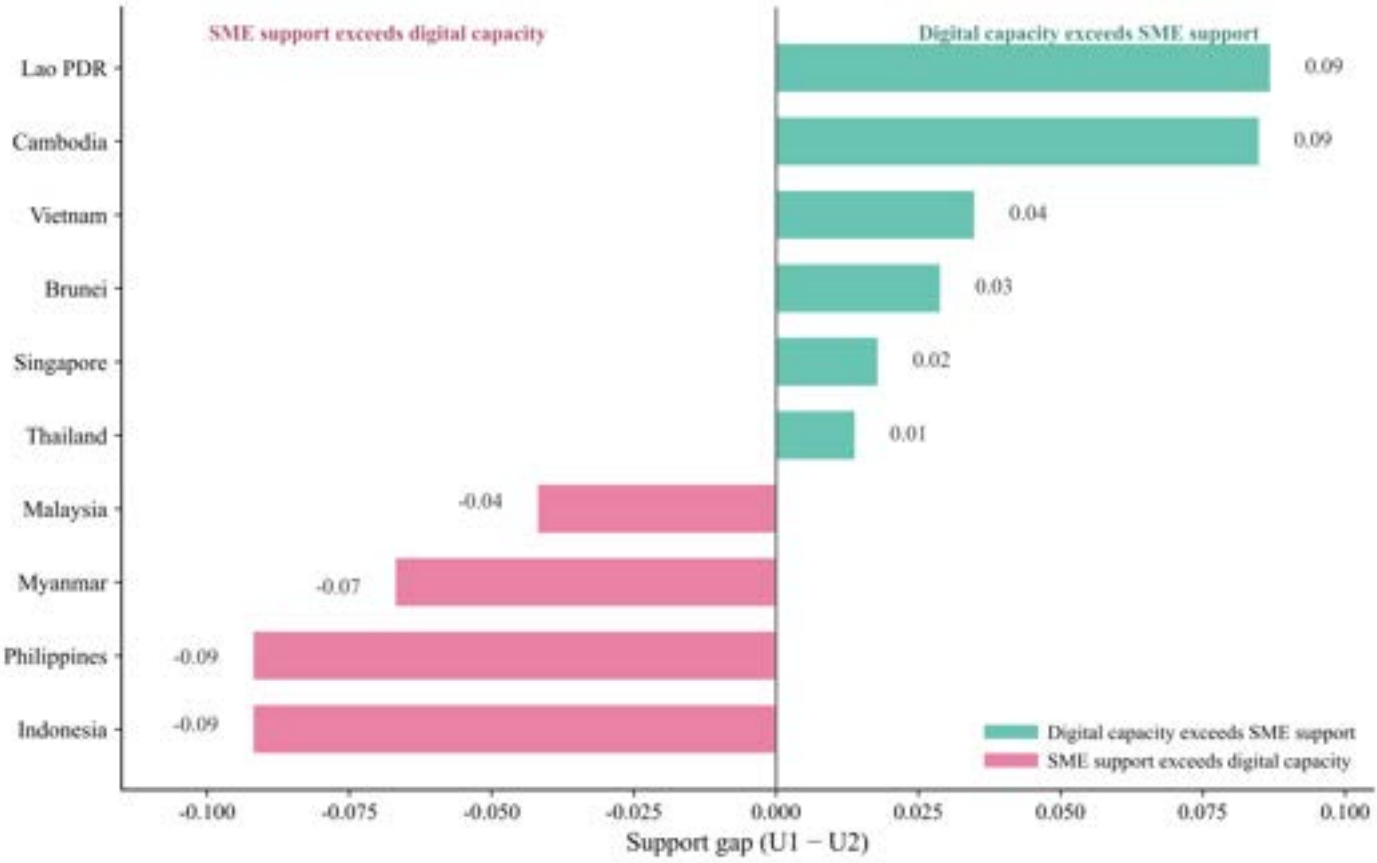

Figure 4: Support Gap between Digital Capacity and SME Support

Malaysia records a small negative gap of -0.04. Its SME support capacity is therefore slightly ahead of its digital and technology capacity. The diagnosis is consistent with Malaysia's mature SME policy architecture, while also identifying the next policy frontier. Support institutions are already comparatively strong; the remaining issue is whether ordinary SMEs can absorb higher-level digital and AI-related capabilities beyond the most advanced firms. Indonesia and the Philippines show larger negative gaps, both around -0.09, suggesting that their SME support foundations are relatively stronger than their digital and innovation bases. For both economies, the next stage requires sharper investment in digital skills,

data capability and firm-level technology upgrading, rather than only expanding generic enterprise support (Maharani, 2023; Quimba et al., 2024; Santosa & Surgawati, 2024).

Dimension-Level Diagnostic Heatmap

Figure 5 returns the analysis to the original ASPI dimensions. High coordination is not produced by one strong dimension alone. Frontier economies tend to combine stronger technology and innovation scores with stronger finance, market access, institutional, regulatory and skills-related conditions. The heatmap therefore reinforces the ecosystem reading of AI-SME readiness: technology matters, but it becomes useful only when embedded in a wider support architecture.

The treatment of environmental policy is also clarified by the heatmap. Dimension 2 remains visible because sustainability is part of the wider SME policy environment, but it is not folded into U_2, which is designed to capture direct entrepreneurial support capacity. The explicit decoupling preserves measurement integrity while still recognising that ASEAN's digital transformation agenda increasingly intersects with sustainability and inclusion (ASEAN, 2021; OECD & ERIA, 2024).

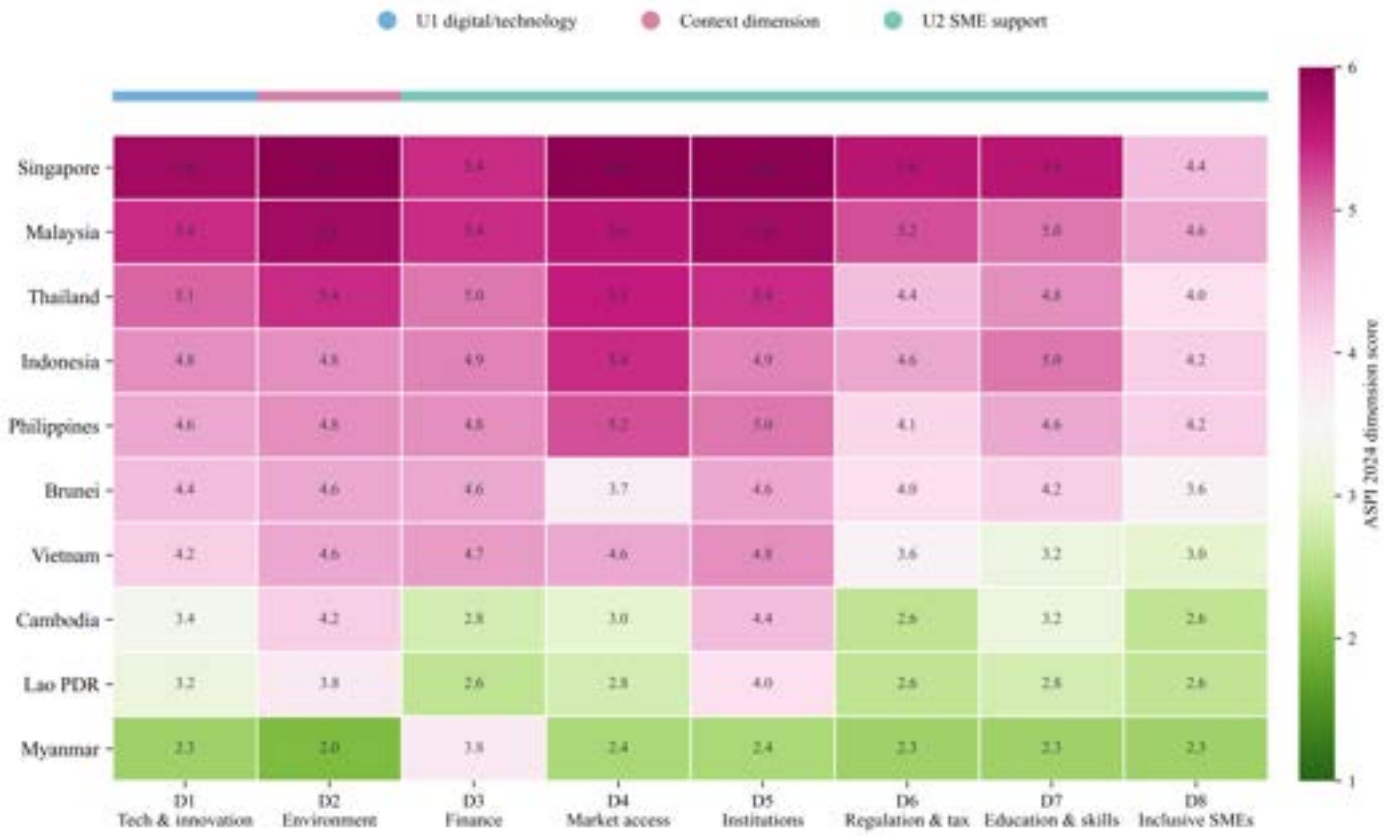

Figure 5: ASPI dimension-level heatmap

The lower-ranked economies are not weak because of a single missing component. Their profiles show deficits across several policy dimensions at once. This matters for policy transfer. AI sandboxes, advanced advisory schemes or sector-specific AI programmes may be useful for Singapore and Malaysia, but they are unlikely to travel well into economies where finance, skills, institutions and legal certainty remain fragile.

The empirical alignment across the diagnostic layers indicates that AI-SME readiness across ASEAN is constrained by coordination rather than individual capacity alone. Maximising the economic yield of digital infrastructure requires parallel investment in non-technological ecosystems, especially small-firm credit access, practical skills acquisition and structured institutional facilitation. Policy interventions that neglect this dual-system synchronization are likely to produce fractured technology adoption and widen the sub-regional digital divide.

CONCLUSION

Main Findings

By applying the Coupling Coordination Degree Model, this study evaluates the alignment between digital and technology capacity U_1 and SME entrepreneurial support capacity U_2 across ten ASEAN economies. The results show that ASEAN SME AI readiness does not form a smooth regional continuum. Singapore and Malaysia occupy the coordination frontier, Thailand, Indonesia and the Philippines remain in the high-coordination group, Brunei Darussalam and Viet Nam appear as transitional cases, while Cambodia, Lao PDR and Myanmar face weaker subsystem coordination.

The $U_1 - U_2$ map reveals a diagonal ladder rather than separate digital-led or support-led configurations. Digital and technology capacity tends to rise together with SME support capacity, suggesting that AI-SME readiness depends on synchronised ecosystem development rather than digital infrastructure alone. The support gap $U_1 - U_2$ further separates readiness level from readiness balance. Cambodia and Lao PDR show positive gaps that reflect low-base asymmetry, Malaysia records a small negative gap that points to stronger SME support than technological absorption, and Indonesia and the Philippines display larger negative gaps where support foundations appear stronger than digital and innovation capacity.

Theoretical and Methodological Contributions

The main contribution of this study lies in separating AI-SME readiness level from AI-SME readiness balance. Existing studies often examine firm-level adoption intention, technological awareness or organisational readiness (Boonmee et al., 2025; Lada et al., 2023; Quimba et al., 2024). This paper moves the discussion to subsystem coordination, treating SME AI readiness as a dual-capacity structure in which digital and technology capacity must be matched by entrepreneurial support capacity.

The study also translates the Technology-Organisation-Environment perspective and absorptive capacity logic into a country-level diagnostic framework (Cohen & Levinthal, 1990; Tornatzky & Fleischer, 1990; Zahra & George, 2002). For SMEs, the external environment is not only a background condition. It is the support architecture through which firms obtain finance, skills, advisory services, regulatory clarity and market access. Methodologically, the combination of CCDM and $U_1 - U_2$ support-gap analysis avoids reducing ASEAN AI-SME readiness to a single ranking. The coordination score identifies where each economy stands, while the support gap identifies the direction of subsystem imbalance.

Policy Implications

The results point to differentiated policy priorities across ASEAN. For high-coordination economies, including Singapore, Malaysia, Thailand, Indonesia and the Philippines, policy should move from broad digitalisation campaigns toward firm-level AI usability. More targeted instruments are needed, including SME AI advisory services, sector-specific AI adoption programmes, data governance support, AI skills vouchers and SME-oriented regulatory sandboxes. This direction is consistent with ASEAN's Digital

Economy Framework Agreement agenda, where cross-border digital trade, data governance and interoperable digital rules are becoming more central to regional competitiveness (ASEAN, 2023).

Malaysia requires a narrower policy reading. Its small negative support gap suggests that SME support capacity is slightly ahead of digital and technology capacity. Programmes under the National Artificial Intelligence Roadmap 2021–2025 and the New Industrial Master Plan 2030 should therefore be connected more directly to ordinary SMEs through practical AI use cases, data capability training and sector-specific advisory channels (MITI, 2023; MOSTI, 2021). The policy issue is no longer basic SME institutional construction, but technological absorption among conventional, non-frontier firms.

For Brunei Darussalam and Vietnam, the priority is ecosystem alignment. Vietnam's manufacturing base and emerging AI-related applications indicate technological potential, but broader SME finance, technical training and institutional coordination need to develop at the same pace (Dey et al., 2024; Roux et al., 2025). Brunei Darussalam faces a smaller and narrower SME base, making enterprise participation and sectoral diversification more urgent. The *Asia small and medium-sized enterprise monitor 2024* similarly frames resilient MSME growth as an ecosystem issue rather than a single financing or technology problem (ADB, 2024).

For Cambodia, Lao PDR and Myanmar, advanced AI deployment should not be the first policy layer. Their low coordination scores and low-base positive gaps indicate fragile foundational conditions. Policy should prioritise digital literacy, basic connectivity, SME financing, vocational training, business registration support and legal certainty before large-scale AI adoption programmes. Regional investment and infrastructure flows may improve connectivity, but such gains become productive for SMEs only when matched by domestic capability-building and institutional support (ASEAN Secretariat & UNCTAD, 2022).

At the ASEAN level, the findings support differentiated policy sequencing rather than a single AI-readiness template. The ASEAN Digital Masterplan 2025 already places connectivity, trusted digital services, e-government and cross-border digital trade within the regional transformation agenda (ASEAN, 2021). The empirical results suggest that this regional agenda must be translated into different national pathways: adoption-deepening for frontier economies, ecosystem alignment for transitional economies, and foundational SME capacity-building for late-developing economies.

Limitations and Future Research

Several limitations remain. First, the analysis relies on ASPI 2024 country-level policy indicators. The results measure structural readiness rather than actual firm-level AI adoption. A high coordination score does not prove widespread SME AI use, and a low score does not rule out localised firm innovation. Future studies can extend the analysis using SME surveys, administrative data or sector-level indicators of AI and digital technology use.

Second, the CCDM is diagnostic rather than causal. It maps coordination and imbalance between U_1 and U_2, but it does not estimate whether subsystem coordination improves SME performance. Future research could combine the coordination index with longitudinal data to test whether improvements in readiness balance predict later changes in SME digital adoption, productivity or export participation.

Finally, ASPI 2024 provides a cross-sectional policy snapshot. As ASEAN digital policies, DEFA negotiations and national AI strategies evolve, future research can examine whether economies move upward along the coordination ladder, remain locked in low-base asymmetry or develop new forms of subsystem imbalance.

Final Concluding Remarks

ASEAN's SME AI challenge is not a shortage of digital ambition, but a coordination deficit between technological foundations and the everyday support systems through which smaller firms absorb new technologies. Digital infrastructure can widen opportunity only when matched by finance, skills, institutions, market access and policy coordination. Without that alignment, AI readiness will remain concentrated in stronger economies and better-resourced firms, leaving many smaller enterprises at the edge of the digital transition.

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REFERENCES

ADB. (2024). *Asia small and medium-sized enterprise monitor 2024: Designing an MSME ecosystem for resilient growth in Asia and the Pacific*. Asian Development Bank.

ASEAN. (2021). *ASEAN Digital Masterplan 2025*. ASEAN Secretariat.

ASEAN. (2023, September 3). *ASEAN launches world's first regionwide digital economy framework agreement*. ASEAN Secretariat.

ASEAN Secretariat, & UNCTAD. (2022). *ASEAN investment report 2022: Pandemic recovery and investment facilitation*. ASEAN Secretariat.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly, 37*(2), 471–482. https://doi.org/10.25300/MISQ/2013/37:2.3

Boonmee, C., Mangkalakeeree, J., & Jeong, Y. (2025). Towards sustainable digital transformation: AI adoption barriers and enablers among SMEs in Northern Thailand. *Sustainable Futures, 10*, 101169. https://doi.org/10.1016/j.sftr.2025.101169

Chong, N., Nguyen, T., Tong, A., & Zainol, Z. (2026). Emerging technology adoption in Southeast Asia (SEA)'s micro, small and medium enterprises (MSMEs): A systematic review-based conceptual framework. In N. Noor, T. K. Lim, H. Jang, J. Wood, & K. Thirumaran (Eds.), *Emerging technologies and business development in the tropics: A roadmap for transformation* (pp. 4–20). Routledge. https://doi.org/10.4324/9781003586043-2

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152. https://doi.org/10.2307/2393553

Dey, P. K., Chowdhury, S., Abadie, A., Vann Yaroson, E., & Sarkar, S. (2024). Artificial intelligence-driven supply chain resilience in Vietnamese manufacturing small- and medium-sized enterprises. *International Journal of Production Research, 62*(15), 5417–5456. https://doi.org/10.1080/00207543.2023.2179859

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Duan, Y., Dwivedi, R., Edwards, J., Eirug, A., Galanos, V., Ilavarasan, P. V., Janssen, M., Jones, P., Kar, A. K., Kizgin, H., Kronemann, B., Lal, B., Lucini, B., Medaglia, R., ... Williams, M. D. (2021). Artificial intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management, 57*, 101994. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Enshassi, M., Nathan, R. J., Soekmawati, & Ismail, H. (2025). Unveiling barriers and drivers of AI adoption for digital marketing in Malaysian SMEs. *Journal of Open Innovation: Technology, Market, and Complexity, 11*(2), 100519. https://doi.org/10.1016/j.joitmc.2025.100519

Isono, I., & Prilliadi, H. (2023). *Accelerating artificial intelligence discussions in ASEAN: Addressing disparities, challenges, and regional policy imperatives*. Economic Research Institute for ASEAN and East Asia.

Jalil, M. F., Lynch, P., Marikan, D. A. B. A., & Isa, A. H. B. M. (2025). The influential role of artificial intelligence (AI) adoption in digital value creation for small and medium enterprises (SMEs): Does technological orientation mediate this relationship? *AI & Society, 40*(3), 1875–1896. https://doi.org/10.1007/s00146-024-01969-1

Lada, S., Chekima, B., Karim, M. R. A., Fabeil, N. F., Ayub, M. S., Amirul, S. M., Ansar, R., Bouteraa, M., Fook, L. M., & Zaki, H. O. (2023). Determining factors related to artificial intelligence (AI) adoption among Malaysia's small and medium-sized businesses. *Journal of Open Innovation: Technology, Market, and Complexity, 9*(4), 100144. https://doi.org/10.1016/j.joitmc.2023.100144

Maharani, R. (2023). Organizational readiness for AI adoption in Indonesian manufacturing SMEs. *Journal of Sustainability Industrial Engineering and Management System, 2*(1). https://doi.org/10.56953/jsiems.v2i1.30

Marsan, G. A. (2021). Artificial intelligence in South East Asia: Upskilling and reskilling to narrow emerging digital divides in the post-pandemic recovery. *Georgetown Journal of Asian Affairs, 7*, 143–152.

MDEC. (n.d.). *About MDEC*. Retrieved May 24, 2026, from https://mdec.my/about-mdec

MITI. (2023). *New industrial master plan 2030*. Government of Malaysia.

MOSTI. (2021). *Malaysia National Artificial Intelligence Roadmap 2021–2025*. Government of Malaysia.

Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management: Reinventing innovation management research in a digital world. *MIS Quarterly, 41*(1), 223–238. https://doi.org/10.25300/MISQ/2017/41:1.03

Noor, N., Lim, T. K., Jang, H., Wood, J., & Thirumaran, K. (Eds.). (2026). *Emerging technologies and business development in the tropics: A roadmap for transformation*. Routledge. https://doi.org/10.4324/9781003586043

OECD. (2021). *The digital transformation of SMEs*. OECD Publishing.

OECD, & ERIA. (2024). *SME policy index: ASEAN 2024: Enabling sustainable growth and digitalisation*. OECD Publishing.

OECD, & JRC. (2008). *Handbook on constructing composite indicators: Methodology and user guide*. OECD Publishing. https://doi.org/10.1787/9789264043466-en

Oliveira, T., & Martins, M. F. (2011). Literature review of information technology adoption models at firm level. *The Electronic Journal Information Systems Evaluation, 14*(1), 110–121.

Quimba, F. M. A., Moreno, N. I. S., & Salazar, A. M. C. (2024). *Readiness for AI adoption of Philippine business and industry: The government's role in fostering innovation- and AI-driven industrial development* (PIDS Discussion Paper Series No. 2024-35). Philippine Institute for Development Studies. https://doi.org/10.62986/dp2024.35

Roux, M., Chowdhury, S., Dey, P. K., Vann Yaroson, E., Pereira, V., & Abadie, A. (2025). Small and medium-sized enterprises as technology innovation intermediaries in sustainable business ecosystem: Interplay between AI adoption, low carbon management and resilience. *Annals of Operations Research, 355*(2), 1537–1586. https://doi.org/10.1007/s10479-023-05760-1

Santosa, A. D., & Surgawati, I. (2024). Artificial intelligence (AI) adoption as marketing tools among micro, small, and medium enterprises (MSMEs) in Indonesia. *Jurnal Sosial Humaniora, 17*(1), 91–102. https://doi.org/10.12962/j24433527.v17i1.20520

SME Corp. Malaysia. (n.d.). *About SME Corp. Malaysia*. Retrieved May 24, 2026, from https://www.smecorp.gov.my/index.php/en/about-sme-corp-malaysia

Spigel, B. (2017). The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice, 41*(1), 49–72. https://doi.org/10.1111/etap.12167

Stam, E. (2015). Entrepreneurial ecosystems and regional policy: A sympathetic critique. *European Planning Studies, 23*(9), 1759–1769. https://doi.org/10.1080/09654313.2015.1061484

Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington Books.

UNCTAD. (2021). *Digital economy report 2021: Cross-border data flows and development: For whom the data flow*. United Nations.

Verma, U. S., Somjai, S., & Rusmee, A. (2024). Readiness of small and medium-sized enterprises in the Bangkok Metropolitan Area to integrate AI into their marketing strategies. *International Journal of Development Administration Research, 7*(2), 168–182.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems, 28*(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203. https://doi.org/10.5465/amr.2002.6587995