

# From Bytes to Businesses: The Role of Digital Technologies in Fostering Sustainable Entrepreneurship in Asia



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## Abstract

Digital tools are changing how entrepreneurs across Asia start, scale, and sustain their ventures. Drawing together recent work on digital transformation, financial technology (fintech), and sustainable entrepreneurship, this conceptual paper asks how information technology (IT) adoption helps small and medium enterprises (SMEs) and start-ups pursue economic, environmental, and social goals at once. Building on studies of entrepreneurial orientation, organizational resilience, and green finance, it proposes an integrated framework — tested through eight hypotheses (H1–H8) — in which digital adoption operates as a mediated, moderated pathway to sustainable performance rather than a direct cause of it. The review indicates that IT adoption expands market reach, financial inclusion, and resource efficiency, yet its sustainability payoff hinges on entrepreneurial competencies, infrastructure maturity, and policy support that differ sharply across the region. The paper closes with a proposed empirical design, literature-grounded expectations for each hypothesis, and implications for researchers, entrepreneurs, and policymakers.

**Keywords:** digital transformation; sustainable entrepreneurship; information technology adoption; fintech; SMEs; Asia

## Introduction

Across South, Southeast, and East Asia, entrepreneurship is being reshaped by digital tools — e-commerce platforms, mobile fintech, cloud software, and data analytics — that are steadily becoming part of how SMEs and start-ups run day to day. These firms make up most of the region's business base and a large share of its jobs and output, yet many still fall short on productivity, exports, and resilience relative to what they could achieve (Empowering Philippine MSMEs, 2024). At the same time, entrepreneurs face growing pressure to grow in ways that are not just profitable but environmentally sound and socially inclusive.

Where these two pressures meet — digitalization on one side, sustainability on the other — a body of scholarship has emerged around what is now called sustainable entrepreneurship: venture creation that balances financial performance against environmental stewardship and social value (Nambisan et al., 2019). This paper asks a single guiding question — what role do digital technologies play in enabling sustainable entrepreneurship in Asia, and under what conditions is that role strongest? Rather than collecting new data, it takes a conceptual approach, drawing on recent empirical and review studies from Asia and comparable emerging markets to build a testable framework.

Section 2 reviews the literature across four themes: digital adoption and SME performance, entrepreneurial resilience, fintech and green finance, and Asia-specific evidence. Section 3 develops the conceptual framework and hypotheses. Section 4 proposes a methodology for testing it. Section 5 sets out literature-grounded expectations for each hypothesis. Sections 6 through 8 cover implications, limitations, and conclusions.

## 2. Literature Review

### 2.1 Digital Technology Adoption and SME Performance

One strand of research ties digital adoption directly to SME performance and resilience. Nambisan et al. (2019) argue that digital tools change the mechanics of innovation itself — lowering the barriers to starting a venture, enabling new organizational forms, and blurring the line between product and service. Civelek et al. (2023) build on this through a resource-based lens, showing that dynamic capabilities — sensing, seizing, and reconfiguring resources — largely determine whether SMEs turn digital tools into a competitive edge during transformation. A survey of 681 digital entrepreneurs across six ASEAN countries reinforces this: combining specific digital-application use with broader business-model digitalization was associated with more business-model experimentation and measurably better entrepreneurial performance (Asian Development Bank, 2023).

None of this happens automatically, though. Nazir and

Roomi (2021) point to persistent obstacles to e-commerce adoption among emerging-market SMEs — thin digital literacy, weak logistics, and tight financing. In Malaysia's beauty, health, and wellness sector, a positive digital mindset and social norms turned out to predict sustainable technology adoption more strongly than perceived usefulness did, a pattern the authors trace to the region's collectivist culture (Advancing Sustainable Technology Adoption, 2025). Taken together, these findings suggest that adoption in Asian SME settings is driven as much by behavior and culture as by the technology itself.

### 2.2 Entrepreneurial Orientation, Competencies, and Digital Resilience

A second strand places digital adoption inside a broader resilience strategy rooted in entrepreneurial orientation and competencies. Survey data from 381 Indonesian SMEs show that both traits significantly predict a sustainable resilience strategy, which then mediates their relationship with digital technology adoption (Sudirman et al., 2025) — evidence that adoption is less a one-off technical decision than an outcome of an organization's proactiveness, innovativeness, and risk appetite. Ong et al. (2020) find a related pattern among women entrepreneurs, where ICT adoption tracks with business performance and points to digital tools as a route to wider participation in entrepreneurship. Caloffi et al. (2015) add a policy dimension: SMEs collaborate and innovate more readily inside supportive regional innovation systems, a condition just as relevant to digital-ecosystem building in Asia.

### 2.3 Fintech, Green Finance, and Sustainable Entrepreneurship

Fintech sits at an especially important junction in the digital-sustainability story, since it speaks directly to the financing gap that many emerging-Asia entrepreneurs face. A PRISMA-based systematic review of 120 studies finds that fintech adoption — measured through mobile subscriptions, internet use, and ATM density — consistently widens financial inclusion, cuts transaction costs, and opens channels to green finance for renewable energy and climate-resilient infrastructure (Khan & Shahid, 2025). Country evidence points the same way: in India, green finance and fintech jointly support economic growth by strengthening financial structure and environmental outcomes, with fintech's effect leaning more toward environmental quality than raw economic efficiency (Nenavath & Mishra, 2023). Across the BRICS economies, fintech similarly helps channel financing toward green projects and lower emissions, suggesting the two mechanisms reinforce rather than compete with one another (Miled, 2025). China supplies some of the most granular evidence. Using panel data from 30 provinces, Li et al. (2024) show that fintech development actively drives the growth of green-finance markets, while Muganyi et al. (2021) find that fintech-linked green finance

measurably improves environmental protection outcomes, with the strongest effects in provinces further along in low-carbon policy piloting. At the firm level, research set in Saudi Arabia's Vision 2030 context finds that green finance's link to sustainability performance is significantly amplified when firms also pursue fintech adoption and digital transformation together — a three-way interaction among green finance, fintech, and digital maturity (Zaid et al., 2025). Offiong (2025) synthesizes this literature and flags open gaps, notably gender disparities in fintech access and the need for regionally adaptive rather than uniform fintech-for-sustainability strategies — directly relevant given how uneven Asian economies are.

## 2.4 Regional Evidence from Asia

Several Asia-focused studies ground this paper's framework more directly. Subramanian and Tiwari (2025), writing in the *Journal of Asia Entrepreneurship and Sustainability*, examine post-pandemic digital transformation among Asian start-ups and conclude that policy support, infrastructure, and ecosystem maturity together decide whether tech-led entrepreneurship actually becomes sustainable — a pattern echoed in India's post-pandemic food start-up sector (Sharma et al., 2023). Philippine MSMEs contribute heavily to Southeast Asian employment and GDP yet lag on exports, underlining the need for productivity-focused digital transformation (Empowering Philippine MSMEs, 2024), a dynamic Bruce et al. (2023) document similarly in Ghana. Nguyen and Ngo (2021) show that digital financial services narrow, without closing, the financing gap Southeast Asian SMEs face. Burgess et al. (2017), studying social-media adoption among Australian small firms, offer a useful comparative benchmark for the innovation-diffusion patterns later applied to Asian settings.

## 2.5 Barriers and Enabling Conditions

Three enabling conditions recur across this literature: entrepreneurial competencies and a digital mindset, which shape whether entrepreneurs notice and act on digital opportunities (Sudirman et al., 2025; Advancing Sustainable Technology Adoption, 2025); infrastructure and institutional maturity, covering internet access, regulatory clarity, and regional innovation policy (Caloffi et al., 2015; Nazir & Roomi, 2021); and access to digital finance, which decides whether adoption can be funded and scaled (Nguyen & Ngo, 2021; Nenavath & Mishra, 2023). Baporikar (2017) describes these conditions collectively as forms of 'knowledge integration' spanning individual, organizational, and ecosystem levels. Oksanen and Hautamäki (2015) add that sustainable innovation becomes a real competitive advantage only inside a broader innovation ecosystem, not when pursued by firms in isolation.

## 3. Conceptual Framework

### 3.1 Theoretical Foundations

Three theoretical lenses inform the framework below.

The Technology–Organization–Environment (TOE) framework explains firm-level adoption as a joint function of technological, organizational, and environmental context (Tornatzky & Fleischer, 1990) — a good fit here since infrastructure, regulation, and market conditions are treated as co-determinants of adoption, not background noise, matching the region-specific findings in Section 2.4. The dynamic-capabilities view holds that sustained performance depends on a firm's ability to sense opportunities, seize them, and reconfigure resources accordingly (Teece, 2007); this paper treats the 'sustainable resilience strategy' construct from Sudirman et al. (2025) as a domain-specific version of that capability — the organizational routine through which entrepreneurial traits become technology adoption. Finally, Shepherd and Patzelt's (2011) definition of sustainable entrepreneurship — pursuing opportunities that preserve nature, life support, and community while generating economic and non-economic gains — supplies the outcome construct against which digital technology's contribution is judged.

### 3.2 Research Questions

Four research questions organize the inquiry:

RQ1: Do entrepreneurial orientation and competencies shape digital technology adoption directly, or through an organizational resilience capability?

RQ2: How does digital technology adoption — including fintech and financial inclusion — affect economic, environmental, and social sustainability performance?

RQ3: Under what infrastructural, regulatory, and literacy conditions is the digital-adoption/sustainability link strongest?

RQ4: Does green-finance access depend on fintech and digital-transformation maturity for its effect on sustainable performance, as found outside Asia (Zaid et al., 2025), and does this hold across Asia's varied economies?

### 3.3 Hypothesis Development

For RQ1, entrepreneurial orientation and competencies are theorized as antecedents of a resilience-oriented dynamic capability that then drives digital adoption — a chain that mirrors survey evidence from 381 Indonesian SMEs in which both traits significantly predicted a sustainable resilience strategy, which itself significantly predicted digital technology adoption (Sudirman et al., 2025). Adapted to Asian SMEs and start-ups more broadly:

H1: Entrepreneurial orientation is positively associated with the strength of a venture's sustainable resilience strategy.

H2: Entrepreneurial competencies are positively associated with the strength of a venture's sustainable resilience strategy.

H3: A venture's sustainable resilience strategy is positively associated with its digital technology adoption.

H4: Sustainable resilience strategy mediates the link

between (a) entrepreneurial orientation and (b) entrepreneurial competencies, and digital technology adoption.

For RQ2 and RQ4, the fintech and green-finance literature suggests digital financial tools do more than correlate with sustainability — they actively strengthen how green finance converts into performance. A study of 152 employees across Saudi banks found green finance positively predicted sustainable performance, fintech adoption significantly moderated that link, and digital transformation strengthened fintech's moderating effect further, forming a three-way interaction (Zaid et al., 2025). Carried over to Asian ventures rather than banks:

H5: Digital technology adoption is positively associated with sustainable entrepreneurial performance (economic, environmental, and social).

H6: Fintech adoption positively moderates the relationship between green-finance access and sustainable entrepreneurial performance.

H7: The moderating effect in H6 is itself strengthened by the venture's digital transformation maturity — a second-order moderation, consistent with Zaid et al.'s (2025) three-way interaction and with Khan and Shahid's (2025) finding that fintech's sustainability contribution is context-dependent rather than uniform.

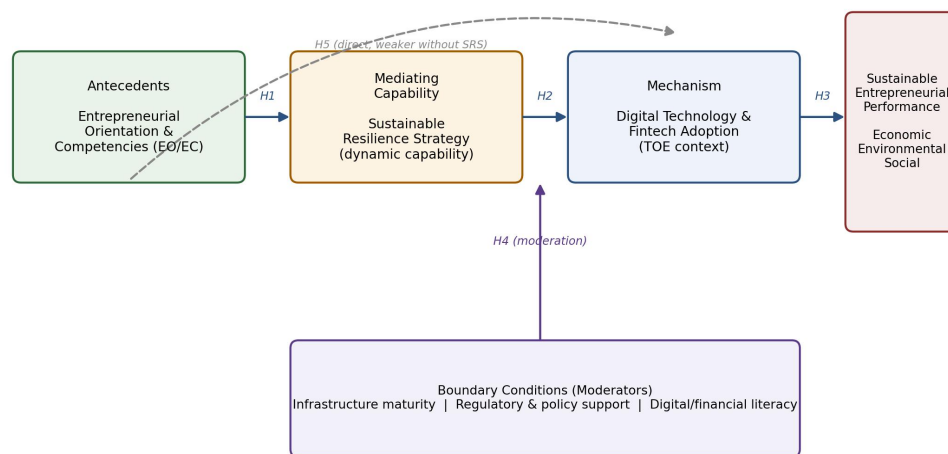
Finally, for RQ3, the TOE framework and the regional

evidence in Sections 2.4–2.5 suggest the H5 relationship is not constant across settings. Infrastructure maturity, regulatory clarity, and digital/financial literacy are treated as boundary conditions rather than simple controls:

H8: The H5 relationship is stronger where digital infrastructure and regulatory support for digital finance are more mature, and weaker where digital and financial literacy are limited (Nazir & Roomi, 2021; Advancing Sustainable Technology Adoption, 2025).

### 3.4 Integrated Model

Figure 1 lays out H1–H8 as one path model. Entrepreneurial orientation and competencies feed a sustainable resilience strategy (H1, H2), which drives digital and fintech adoption both directly (H3) and, per H4, as the main mediating mechanism. Adoption then predicts sustainable performance (H5), an effect that green-finance access strengthens and that is further shaped by two moderators — the venture's own digital-transformation maturity (H6, H7) and the surrounding infrastructure, regulatory, and literacy context (H8). Rather than treating digital technology as a flat, additive input, the model frames adoption as embedded in — and contingent on — an internal capability and an external enabling environment, matching the mixed, context-dependent effects surfaced throughout Section 2.



Framework integrates the Technology-Organization-Environment framework (Tornatzky & Fleischer, 1990), the dynamic-capabilities view (Teece, 2007), and the sustainable-entrepreneurship perspective (Shepherd & Patzelt, 2011).

**Figure 1. Integrated framework linking entrepreneurial antecedents, capability-based digital adoption, and sustainable performance under infrastructural and regulatory boundary conditions.**

## 4. Proposed Methodology for Empirical Validation

H1–H8 are offered here as a testable model rather than an established one. This section sketches the empirical design a future study would need to test it.

### 4.1 Research Design

A sequential explanatory mixed-methods design fits best. A quantitative phase would test H1–H8 through a cross-sectional survey analyzed with Partial Least

Squares Structural Equation Modeling (PLS-SEM), following the approach used to test a comparable EO/EC–resilience–adoption chain among Indonesian SMEs (Sudirman et al., 2025) and the PROCESS-macro moderation approach used for the fintech × green-finance × digital-transformation interaction among Saudi banks (Zaid et al., 2025). PLS-SEM suits a model with reflective constructs, a mediator (H3–H4), and

both first- and second-order moderation (H6–H8) better than covariance-based alternatives at moderate sample sizes. A follow-up qualitative phase — semi-structured interviews with a purposive subsample — would probe the mechanisms behind significant paths and help make sense of null results, particularly around H8's boundary conditions, which survey items alone are unlikely to capture fully.

#### 4.2 Population and Sampling

The target population is SME and start-up owners and senior managers across at least three Asian economies chosen to vary on H8's boundary conditions: a high-connectivity market (e.g., Singapore or South Korea), a large emerging-digital-economy market (e.g., Indonesia or India), and a lower-connectivity market (e.g., a Central or South Asian economy). Within each country, sampling should be stratified by sector and firm age to avoid confounding adoption with sector-specific digitalization norms. Based on sample-adequacy benchmarks in comparable PLS-SEM work (381 respondents in Sudirman et al., 2025; 152 in Zaid et al., 2025, above a G\*Power minimum of 119), a target of 350–400 completed responses (roughly 120–140 per country) would support the full structural model, including H7's second-order term.

#### 4.3 Constructs, Measurement, and Analysis

Constructs should draw on previously validated multi-item scales rather than new items, to keep results comparable with the source studies. Entrepreneurial orientation, entrepreneurial competencies, sustainable resilience strategy, and digital technology adoption would follow the scales validated by Sudirman et al. (2025); green finance access, fintech adoption, and digital transformation would follow Zaid et al. (2025); and sustainable entrepreneurial performance would be modeled as a second-order construct with separate economic, environmental, and social sub-dimensions, consistent with Shepherd and Patzelt (2011), rather than one blended score. A pre-test with 20–30 respondents should check translation and cultural fit before full deployment. On the analysis side, the measurement model would be checked for internal consistency, convergent validity ( $AVE > 0.50$ ), and discriminant validity (Fornell–Larcker, HTMT), with common-method bias and multicollinearity screened via Harman's test and variance inflation factors. H1–H3 and H5 would be tested through bootstrapped structural paths (5,000 resamples); H4 through bias-corrected bootstrap tests of indirect effects; H6–H7 through interaction and simple-slopes analysis; and H8 through multi-group comparison across the three infrastructure strata. Mixed online and in-person distribution is recommended to avoid the digital-access sampling bias a purely online survey would introduce in lower-connectivity strata.

### 5. Results and Discussions

Because this is a conceptual paper, no new data has been collected — what follows are directional expectations for H1–H8 based on the literature in

Section 2 and the two closely analogous studies this framework adapts. These are propositions for future testing, not findings.

#### 5.1 Antecedent-Mediation Chain (H1–H4)

H1 and H2 should hold, in line with the significant  $EO \rightarrow SRS$  ( $\beta = 0.215$ ,  $p < .01$ ) and  $EC \rightarrow SRS$  ( $\beta = 0.554$ ,  $p < .001$ ) paths in Sudirman et al. (2025); competencies likely carry the larger effect, since concrete skills in resource allocation translate more directly into a resilience strategy than orientation alone. H3 should be strongly supported, echoing the  $SRS \rightarrow DTA$  path ( $\beta = 0.65$ ,  $p < .001$ ) — the strongest link in the source model. H4 should hold for both traits, implying entrepreneurial characteristics shape adoption mainly indirectly, via the resilience strategy, rather than directly — consistent with a modest indirect  $EO \rightarrow DTA$  effect (0.139) alongside a larger  $EC \rightarrow DTA$  effect (0.36) in the same study. These paths may run weaker in Asian markets with less digital-infrastructure maturity than Indonesia's, where H8 would be expected to dampen the  $SRS \rightarrow DTA$  link specifically.

#### 5.2 Adoption-Performance and Moderation Paths (H5–H7)

H5 should hold overall, matching the broadly positive economic and social effects of digital and fintech adoption documented in Section 2.3, though its environmental sub-dimension is likely weaker and more context-dependent, echoing Khan and Shahid's (2025) finding that fintech's environmental benefits are less consistent than its inclusion benefits. H6 should hold, paralleling the significant two-way  $GF \times FinTech$  interaction ( $\beta = 0.275$ ,  $p < .05$ ) in Zaid et al. (2025). H7 should hold directionally but more weakly than in the Saudi banking sample, since Asian SME entrepreneurs likely show more varied digital-transformation maturity than a single national banking sector; the three-way interaction in the source study, though positive ( $\beta = 0.346$ ), fell short of conventional significance even there, so H7 remains the most tentative of the performance hypotheses.

#### 5.3 Boundary-Condition Hypothesis (H8)

The multi-group comparison should support H8, with the H5 path strongest in the high-connectivity stratum and weakest in the frontier-market stratum, in line with the infrastructure- and regulation-dependent effects documented in Sections 2.4–2.5. If confirmed, this would mean the framework's real value lies less in one universal coefficient and more in identifying which combination of entrepreneurial capability and external conditions lets digital adoption actually pay off in sustainability terms — RQ3's central concern.

### 6. Discussion and Implications

#### 6.1 Theoretical Implications

This paper contributes to entrepreneurship and information-systems research in three ways. It brings together three literatures — digital adoption, entrepreneurial resilience, and fintech-enabled green finance — usually studied apart, inside a single mediation-and-moderation model rather than a loose thematic summary. It extends the dynamic-

capabilities view (Teece, 2007) by naming sustainable performance, not competitive advantage alone, as the outcome that sensing–seizing–reconfiguring routines are meant to produce, treating Sudirman et al.'s (2025) resilience-strategy construct as an operational proxy for that capability in SMEs. And by building the TOE framework's environmental context into an explicit second-order moderator (H8) rather than a background control, it answers Offiong's (2025) call for regionally adaptive rather than universal theorizing about fintech's role in sustainability.

## 6.2 Practical and Policy Implications

If H1–H4 hold, the practical takeaway for entrepreneurs is that technology spending pays off only alongside deliberate resilience planning — risk assessment, contingency planning, resource allocation — since it is that capability, not orientation alone, that the model predicts converts intent into adoption. If H6–H7 hold, financial institutions and fintech providers have a clear case for bundling green-finance products with fintech onboarding for SME clients, since green finance's effect is predicted to depend on the client's fintech and digital maturity rather than operate independently of it. If H8 holds, the clearest policy message is that infrastructure and regulation are not simply nice-to-haves alongside digital-adoption programs but a precondition for their sustainability payoff — reinforcing the case for sequencing infrastructure investment ahead of or alongside SME digitalization campaigns in lower-connectivity Asian markets.

## 7. Limitations and Future Research

As a conceptual paper, its main limitation is the absence of new primary data testing H1–H8 directly — every expectation in Section 5 is a projection from existing literature, not a finding, and should be read that way. A second limitation is that the two studies most heavily drawn on — Sudirman et al. (2025) and Zaid et al. (2025) — were each conducted in a single country (Indonesia and Saudi Arabia); extrapolating their path structure to a pan-Asian model is itself a hypothesis embedded in H8, not an established fact, and true cross-country coefficients may differ. Third, the literature covered in Section 2 leans toward China, India, and Southeast Asia, with South and Central Asia less represented, which may limit how far the framework generalizes. Future work should prioritize: (1) the multi-country PLS-SEM study outlined in Section 4, with particular attention to H7 and H8 given their tentative status; (2) qualitative case studies of ventures adopting fintech explicitly for sustainability goals; (3) extending the framework to social-entrepreneurship and rural contexts; and (4) examining gender and rural–urban gaps in digital and fintech access, as Offiong (2025) flags.

## 8. Conclusion

Digital technologies are steadily becoming central to how Asian entrepreneurs pursue growth that is economically viable, environmentally sound, and

socially inclusive. This paper has drawn recent literature into a single testable framework in which digital adoption acts as a conditional enabler of sustainable entrepreneurship — mediated by a resilience-oriented capability (H1–H4), moderated by fintech and digital-transformation maturity (H5–H7), and bounded by infrastructure and regulatory context (H8). The proposed methodology and literature-grounded expectations in Sections 4 and 5 give this framework a concrete path toward empirical testing, and offer entrepreneurs, financial institutions, and policymakers a reference point for moving 'from bytes to businesses' in a way that is genuinely sustainable.

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