

Digital Innovation Ecosystems and Entrepreneurial Performance: The Mediating Role of Opportunity Recognition and Technology Adoption in Emerging Economies

Anbarul Yasmin^{1*}, Kristanti Oktripani Lubis², & Yuli Hardina³

¹*Politeknik ATI Padang, Indonesia, ²Politeknik ATI Padang, Indonesia, ³Universitas Negeri Padang, Indonesia

*Co e-mail: anbarulyasmin21@gmail.com¹

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ABSTRACT

This study investigates the relationship between digital innovation ecosystems and entrepreneurial performance, with opportunity recognition and technology adoption as mediating variables. The rapid advancement of digital technologies has fundamentally transformed the entrepreneurial landscape, creating new opportunities and challenges for businesses in emerging economies. Drawing on dynamic capabilities theory and the technology acceptance model (TAM), this research examines how digital innovation ecosystems encompassing digital infrastructure, knowledge networks, and institutional support influence entrepreneurial outcomes. A quantitative research design was employed, utilizing structured questionnaires distributed to 312 small and medium enterprise (SME) owners and managers across five major cities in Indonesia. Structural Equation Modeling with Partial Least Squares (PLS-SEM) was applied to analyze the proposed model. The findings reveal that digital innovation ecosystems exert a significant positive influence on entrepreneurial performance ($\beta = 0.421, p < 0.001$). Furthermore, both opportunity recognition (indirect $\beta = 0.196$, 95% CI [0.124, 0.278]) and technology adoption (indirect $\beta = 0.151$, 95% CI [0.073, 0.233]) significantly mediate this relationship, indicating partial mediation as the direct effect remains significant. The indirect effects confirm that entrepreneurs who operate within robust digital ecosystems are more effective at identifying market opportunities and adopting relevant technologies, which in turn enhances their overall performance. These results contribute to the growing body of literature on digital entrepreneurship and provide practical implications for policymakers seeking to foster entrepreneurial activity in developing countries. The study underscores the importance of building comprehensive digital innovation ecosystems as a strategic lever for SME growth and national economic development.



INTRODUCTION

The global entrepreneurial landscape has undergone a profound transformation driven by the pervasive diffusion of digital technologies. From artificial intelligence and blockchain to cloud computing and the Internet of Things (IoT), digital innovations have disrupted established industries while simultaneously creating unprecedented entrepreneurial opportunities (Nambisan, 2017; Sussan & Acs, 2017). In the context of emerging economies, where institutional voids and resource constraints have historically impeded entrepreneurial activity, digital innovation ecosystems have emerged as critical enablers of sustainable business creation and growth (Li et al., 2021; Roundy et al., 2018).

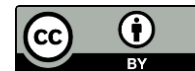
Indonesia, as the largest economy in Southeast Asia with over 64 million SMEs contributing approximately 61% of the national GDP (Kementerian Koperasi dan UKM, 2022), represents a compelling research context for examining the interplay between digital innovation and entrepreneurship. The Indonesian government's commitment to digital transformation, manifested through initiatives such as the Making Indonesia 4.0 roadmap and the National Digital Economy Strategy, has accelerated the development of digital infrastructure and created enabling conditions for tech-enabled entrepreneurship (Bappenas, 2023). Nevertheless, significant heterogeneity persists in how entrepreneurs leverage digital innovations to generate competitive advantage and achieve superior performance outcomes.

Despite the growing scholarly interest in digital entrepreneurship, several critical gaps remain in the existing literature. First, while numerous studies have examined the direct effects of digital technologies on business performance (Elia et al., 2020; Nambisan et al., 2019), relatively few have investigated the systemic role of digital innovation ecosystems as holistic environments that shape entrepreneurial behavior and outcomes. Second, the mechanisms through which digital ecosystems translate into entrepreneurial performance remain insufficiently understood, particularly in the context of developing countries where unique institutional, cultural, and infrastructural factors may moderate these relationships (Autio et al., 2018; Liao et al., 2021).

This study addresses these gaps by proposing and testing a mediated model in which opportunity recognition and technology adoption serve as the primary pathways linking digital innovation ecosystems to entrepreneurial performance. The research is grounded in two complementary theoretical frameworks: (1) dynamic capabilities theory (Teece et al., 1997; Teece, 2018), which emphasizes the role of sensing, seizing, and reconfiguring capabilities in enabling firms to adapt to rapidly changing environments; and (2) the Technology Acceptance Model (Davis, 1989; Venkatesh et al., 2019), which provides a behavioral lens for understanding how individuals and organizations evaluate and adopt new technologies.

The main objectives of this study are threefold: (1) to empirically examine the direct effect of digital innovation ecosystems on entrepreneurial performance among Indonesian SMEs; (2) to investigate the mediating roles of opportunity recognition and technology adoption in this relationship; and (3) to provide evidence-based recommendations for entrepreneurs, managers, and policymakers seeking to harness digital innovation for sustained economic growth. The findings are expected to make both theoretical and practical contributions to the fields of entrepreneurship, strategic management, and digital transformation.

The remainder of this paper is organized as follows. Section 2 reviews the relevant theoretical and empirical literature and develops the research hypotheses. Section 3 describes the research methodology, including the sampling procedure, measurement instruments, and analytical approach. Section 4 presents the empirical results, followed by a discussion of the findings in Section 5. Finally, Section 6 offers conclusions, implications, and directions for future research.



An innovation ecosystem is broadly defined as a dynamic network of interdependent actors including firms, universities, government agencies, investors, and end users whose collaborative and competitive interactions generate and diffuse innovations (Adner, 2017; Oh et al., 2016). The digital dimension adds a layer of technological infrastructure, platforms, data flows, and digital complementarities that amplify the ecosystem's capacity to create and capture value (Jacobides et al., 2018; Thomas & Autio, 2020).

Digital innovation ecosystems are characterized by four core dimensions: (1) digital infrastructure, encompassing broadband connectivity, cloud services, and IoT platforms; (2) knowledge networks, comprising university-industry collaborations, research centers, and knowledge spillovers; (3) institutional support, including regulatory frameworks, government incentives, and intellectual property protections; and (4) platform ecosystems, referring to digital marketplaces and API-based ecosystems that enable complementary innovation (Bogers et al., 2019; Nambisan et al., 2019; Rong et al., 2018).

For entrepreneurs, digital innovation ecosystems provide access to critical resources including knowledge, technology, talent, and capital that would otherwise be prohibitively costly to acquire independently (Autio et al., 2018; Li et al., 2021). The ecosystem perspective thus shifts the unit of analysis from the individual firm to the broader relational context in which entrepreneurial activity is embedded, offering a more nuanced understanding of how environmental conditions shape entrepreneurial success.

Entrepreneurial performance is a multidimensional construct that encompasses financial outcomes (e.g., revenue growth, profitability), market outcomes (e.g., market share, customer acquisition), and innovation outcomes (e.g., new product development, process improvements) (Lumpkin & Dess, 1996; Wiklund & Shepherd, 2005; Zacca & Dayan, 2018). In the context of SMEs, performance is often assessed against benchmarks such as sales growth, employment creation, and return on investment, as well as subjective measures of goal attainment and entrepreneur satisfaction (Ahmad & Seet, 2019; Shepherd & Wiklund, 2005).

Recent scholarship has increasingly adopted a resource-based view (RBV) lens to understand entrepreneurial performance, arguing that firms that accumulate and deploy unique, inimitable resources including digital capabilities are better positioned to achieve sustainable competitive advantages (Barney, 1991; Priem & Butler, 2001; Wernerfelt, 2019). In the digital age, these resources increasingly include data assets, platform capabilities, and digital relationship networks, which collectively constitute a firm's digital capital (Bharadwaj et al., 2013; Yoo et al., 2012).

Opportunity recognition defined as the cognitive process through which entrepreneurs identify, evaluate, and exploit market opportunities is widely regarded as a foundational element of the entrepreneurial process (Ardichvili et al., 2003; Kirzner, 1997; Shane & Venkataraman, 2000). Scholars have linked opportunity recognition to prior knowledge, social networks, cognitive frameworks, and environmental alertness (Liao & Welsch, 2005; Singh, 2000; Tang et al., 2012).

Digital innovation ecosystems enhance opportunity recognition through several mechanisms. First, by providing entrepreneurs with real-time access to market information and consumer data, digital platforms reduce information asymmetries and lower the cognitive barriers to opportunity identification (Autio et al., 2018; Nambisan, 2017). Second, knowledge spillovers within innovation clusters and digital networks expose entrepreneurs to novel combinations of ideas and technologies, stimulating pattern recognition and creative problem-solving (Roundy et al., 2018). Third, the collaborative nature of digital ecosystems enables entrepreneurs to co-create and validate opportunities with customers, partners, and complementors before committing significant resources (Adner, 2017; Jacobides et al., 2018).

Based on this reasoning, we propose that opportunity recognition mediates the relationship between digital innovation ecosystems and entrepreneurial performance. Specifically, entrepreneurs embedded in rich



digital ecosystems are better able to recognize and act on market opportunities, which in turn translates into superior performance outcomes.

H1: Digital innovation ecosystems have a significant positive effect on opportunity recognition among SME entrepreneurs.

H2: Opportunity recognition has a significant positive effect on entrepreneurial performance.

H3: Opportunity recognition mediates the relationship between digital innovation ecosystems and entrepreneurial performance.

Technology adoption refers to the process by which individuals and organizations decide to use new technologies in their activities (Davis, 1989; Rogers, 2003; Venkatesh et al., 2003). The Technology Acceptance Model (TAM) posits that perceived usefulness and perceived ease of use are the primary determinants of technology adoption intentions, while subsequent extensions have incorporated social influence, facilitating conditions, and individual innovativeness as additional predictors (Venkatesh et al., 2019; Williams et al., 2021).

Digital innovation ecosystems facilitate technology adoption by reducing adoption costs and risks, providing technical support and training, and creating normative pressures that encourage technology use (Autio et al., 2018; Elia et al., 2020). Moreover, the platform dynamics inherent in digital ecosystems generate network effects that amplify the value of widely adopted technologies, further incentivizing entrepreneurs to embrace new digital tools and solutions (Parker et al., 2018; Rochet & Tirole, 2003).

We thus propose that technology adoption serves as a second mediating pathway linking digital innovation ecosystems to entrepreneurial performance. Entrepreneurs who successfully adopt digital technologies including e-commerce platforms, enterprise resource planning (ERP) systems, customer relationship management (CRM) tools, and social media marketing solutions are better equipped to improve operational efficiency, enhance customer engagement, and introduce innovative products and services.

H4: Digital innovation ecosystems have a significant positive effect on technology adoption among SME entrepreneurs.

H5: Technology adoption has a significant positive effect on entrepreneurial performance.

H6: Technology adoption mediates the relationship between digital innovation ecosystems and entrepreneurial performance.

H7: Digital innovation ecosystems have a significant positive direct effect on entrepreneurial performance.

METHODS

This study adopted a quantitative, cross-sectional survey design. The target population consisted of SME owners and managers operating in five major Indonesian cities: Jakarta, Surabaya, Bandung, Yogyakarta, and Medan. These cities were selected based on the availability of digital infrastructure, the density of entrepreneurial activity, and geographic diversity. A purposive sampling technique was employed, with inclusion criteria requiring respondents to: (a) own or manage an SME with 1–250 employees; (b) have been in operation for at least two years; and (c) have access to and use of at least one digital technology in their business operations.

The sampling frame was constructed by combining registration lists obtained from the local offices of the Ministry of Cooperatives and SMEs (Dinas Koperasi dan UKM) in each of the five target cities with membership directories from regional chambers of commerce (KADIN) and digital SME business communities active on social media platforms. Respondents were recruited through a combination of channels: (a) direct, in-person distribution of the questionnaire at SME networking events, business incubator activities,

and cooperative meetings; and (b) online distribution of the same instrument via a Google Forms link shared through SME association mailing lists, WhatsApp business groups, and community moderators, who assisted in disseminating the survey to their members. Data collection was carried out over a twelve-week period between March and May 2024. To ensure geographic balance across the five target cities, a proportional quota was applied within the purposive framework, targeting approximately 60–70 respondents per city in line with each city’s relative share of registered SMEs. Prior to completing the substantive questionnaire, respondents answered a short screening section verifying that they met all three inclusion criteria; individuals who did not meet these criteria were thanked and excluded from further participation. Participation was voluntary and anonymous, and informed consent was obtained from all respondents prior to data collection, in accordance with standard ethical protocols for survey-based social science research. Of 385 questionnaires distributed (267 in person and 118 online), 337 were returned (a response rate of 87.5%), of which 25 were excluded due to incomplete responses, straight-lining (identical responses across all items), or failure to pass attention-check items embedded in the questionnaire, yielding a final valid sample of 312 respondents (an effective usable response rate of 81.0%).

Based on the recommended guidelines for PLS-SEM (Hair et al., 2019), which suggest a minimum sample size of ten times the maximum number of paths pointing at any construct in the model, a target sample of 300 respondents was established. After eliminating incomplete and inconsistent responses, a final sample of 312 respondents was retained for analysis. Table 1 presents the demographic profile of the sample.

Table 1. Demographic Profile of Respondents (n = 312)

Variable	Category	Frequency	Percentage (%)
Gender	Male	189	60.6
	Female	123	39.4
Age	< 30 years	74	23.7
	30–45 years	162	51.9
	> 45 years	76	24.4
Education	High School	47	15.1
	Diploma/Associate	68	21.8
	Bachelor's Degree	154	49.4
	Master's/Doctoral	43	13.8
Business Sector	Trade/Retail	98	31.4
	Manufacturing	71	22.8
	Services	86	27.6
	F&B / Culinary	57	18.3
Years in Operation	2–5 years	121	38.8
	6–10 years	109	35.0
	> 10 years	82	26.3

All constructs were measured using multi-item reflective scales adapted from validated instruments in the extant literature. The Digital Innovation Ecosystem (DIE) scale was adapted from Thomas and Autio (2020) and Li et al. (2021), with an initial pool of 12 items measuring digital infrastructure (4 items), knowledge networks (4 items), and institutional support (4 items). Opportunity Recognition (OR) was adapted from Ardichvili et al. (2003) and Tang et al. (2012), with an initial pool of 8 items capturing alertness, search behavior, and pattern recognition. Technology Adoption (TA) was adapted from Venkatesh et al. (2019) and Williams et al. (2021), with an initial pool of 9 items encompassing perceived usefulness, perceived ease of



use, and behavioral intention. Entrepreneurial Performance (EP) was adapted from Wiklund and Shepherd (2005) and Zacca and Dayan (2018), with an initial pool of 10 items covering financial, market, and innovation performance dimensions. The initial instrument therefore comprised 39 indicators. Following the measurement model assessment, 24 indicators were removed and 15 indicators were retained in the final model (DIE = 4, OR = 3, TA = 4, EP = 4). All results reported in this study, including Figure 1 and Tables 2 to 5, are based on these 15 retained indicators.

All items were rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire was initially developed in English and then translated into Bahasa Indonesia using the back-translation procedure (Brislin, 1970) to ensure conceptual equivalence. A pilot study with 45 respondents was conducted to assess the clarity and reliability of the items prior to the main data collection.

Data analysis was conducted in two stages. First, descriptive statistics and normality tests were performed using SPSS 26.0. Second, PLS-SEM was applied using SmartPLS 4.0 (Ringle et al., 2022) to assess the measurement model (outer model) and structural model (inner model). The measurement model was evaluated based on internal consistency (Cronbach's alpha and composite reliability), convergent validity (average variance extracted, AVE), and discriminant validity (Fornell-Larcker criterion and HTMT ratio). The structural model was assessed using path coefficients, coefficient of determination (R^2), effect sizes (f^2), and bootstrapping with 5,000 resamples to determine the significance of direct and indirect effects (Hair et al., 2019; Henseler et al., 2015).

Common method variance (CMV) was addressed through procedural remedies (e.g., anonymous surveys, reversed items) and statistical tests, including Harman's single-factor test and the full-collinearity test (Podsakoff et al., 2003). The variance inflation factor (VIF) for all constructs was below 3.3, indicating the absence of significant CMV bias.

RESULTS

1. Measurement Model Evaluation

Table 2 presents the results of the measurement model assessment. All constructs demonstrated satisfactory internal consistency, with Cronbach's alpha values ranging from 0.823 to 0.901 and composite reliability (CR) values ranging from 0.869 to 0.928, all exceeding the recommended threshold of 0.70 (Hair et al., 2019). Convergent validity was confirmed, as all AVE values exceeded 0.50, with a range of 0.558 to 0.632 across constructs. The outer loadings of all 15 indicators ranged from 0.701 to 0.842, exceeding the recommended threshold of 0.70.

Table 2. Measurement Model Results

Construct		Cronbach's α	CR	AVE	Loadings Range
Digital Ecosystem indicators	Innovation (DIE), 4	0.891	0.917	0.632	0.756–0.842
Opportunity Recognition (OR), 3 indicators		0.847	0.879	0.629	0.764–0.821
Technology Adoption (TA), 4 indicators		0.823	0.869	0.558	0.701–0.786

Entrepreneurial Performance (EP), 4 indicators	0.901	0.928	0.577	0.718–0.804
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Discriminant validity was assessed using the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio. The square root of the AVE for each construct exceeded its correlations with all other constructs (Fornell & Larcker, 1981). All HTMT values were below 0.85 (range 0.548 to 0.706), confirming discriminant validity (Henseler et al., 2015). Table 3 presents the Fornell-Larcker matrix (lower triangle, with the square roots of AVE on the diagonal) and the HTMT ratios (upper triangle).

Table 3. Discriminant Validity: Fornell-Larcker Criterion (Lower Triangle) and HTMT Ratio (Upper Triangle)

Construct	DIE	OR	TA	EP
DIE	0.795	0.683	0.614	0.706
OR	0.612	0.793	0.548	0.662
TA	0.547	0.489	0.747	0.587
EP	0.638	0.591	0.523	0.760

Note: Bold diagonal values represent the square root of AVE; values below the diagonal are construct correlations (Fornell-Larcker criterion); values above the diagonal are HTMT ratios (threshold < 0.85).

2. Structural Model Evaluation

The structural model results are summarized in Tables 4 and 5. Prior to assessing path coefficients, we checked for multicollinearity using the VIF criterion. All VIF values were below 3.3, indicating that multicollinearity was not a concern (Hair et al., 2019). The R^2 values for Opportunity Recognition, Technology Adoption, and Entrepreneurial Performance were 0.374, 0.299, and 0.512, respectively, indicating moderate to substantial explanatory power.

To improve the clarity of the proposed relationships, as recommended in the review of this manuscript, the complete structural model (path diagram) generated in SmartPLS 4, including standardized path coefficients and R^2 values for each endogenous construct, is presented in Figure 1.

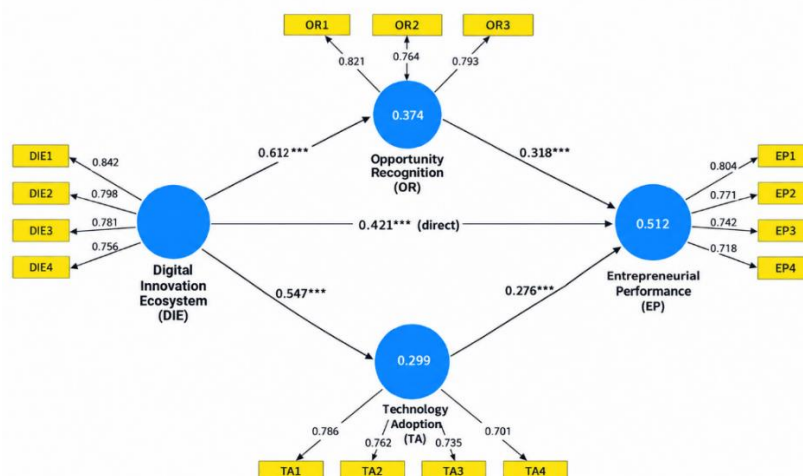


Figure 1. Structural Model (PLS-SEM Path Diagram)



*Note: Values are standardized path coefficients from bootstrapping with 5,000 resamples; *** $p < 0.001$. The measurement model displays the 15 indicators retained from the initial 39. Diagram generated based on SmartPLS 4 output (Ringle et al., 2022).*

Table 4. Direct Path Coefficients and Hypothesis Testing

Hypothesis	Path	β	SE	t-value	p-value	Result
H1: DIE $\rightarrow$ OR	0.612	0.612	0.052	11.77	< 0.001	Supported
H2: OR $\rightarrow$ EP	0.318	0.318	0.061	5.21	< 0.001	Supported
H4: DIE $\rightarrow$ TA	0.547	0.547	0.058	9.43	< 0.001	Supported
H5: TA $\rightarrow$ EP	0.276	0.276	0.068	4.06	< 0.001	Supported
H7: DIE $\rightarrow$ EP (direct)	0.421	0.421	0.064	6.58	< 0.001	Supported

Table 5. Indirect Effects (Mediation Analysis)

Indirect Path	Indirect β	SE	95% CI	t-value	Result
DIE $\rightarrow$ OR $\rightarrow$ EP (H3)	0.196	0.039	[0.124, 0.278]	5.03	Supported
DIE $\rightarrow$ TA $\rightarrow$ EP (H6)	0.151	0.041	[0.073, 0.233]	3.68	Supported
Total Indirect Effect	0.347	0.055	[0.241, 0.459]	6.31	Significant

As shown in Table 4, the digital innovation ecosystem exerted a significant positive effect on opportunity recognition ($\beta = 0.612$, $t = 11.77$, $p < 0.001$), supporting H1. Opportunity recognition, in turn, had a significant positive effect on entrepreneurial performance ($\beta = 0.318$, $t = 5.21$, $p < 0.001$), supporting H2. Similarly, the digital innovation ecosystem positively influenced technology adoption ($\beta = 0.547$, $t = 9.43$, $p < 0.001$, H4 supported), and technology adoption significantly predicted entrepreneurial performance ($\beta = 0.276$, $t = 4.06$, $p < 0.001$, H5 supported). The direct effect of digital innovation ecosystems on entrepreneurial performance was also significant ($\beta = 0.421$, $t = 6.58$, $p < 0.001$), supporting H7.

The mediation analysis results (Table 5) confirmed significant indirect effects of digital innovation ecosystems on entrepreneurial performance through both opportunity recognition ($\beta = 0.196$, 95% CI [0.124, 0.278]) and technology adoption ($\beta = 0.151$, 95% CI [0.073, 0.233]). The total indirect effect was 0.347, indicating partial mediation, as the direct effect remained significant. The total effect of digital innovation ecosystems on entrepreneurial performance was 0.768 ($t = 13.24$, 95% CI [0.654, 0.882]), of which the total indirect effect accounted for approximately 45%. H3 and H6 were therefore both supported.

DISCUSSION

1. Digital Innovation Ecosystems and Entrepreneurial Performance

The empirical results of this study provide robust support for the proposed theoretical model. The finding that digital innovation ecosystems exert a significant direct and indirect positive effect on entrepreneurial performance is consistent with the tenets of dynamic capabilities theory (Teece, 2018) and corroborates earlier empirical work by Li et al. (2021) and Autio et al. (2018). Entrepreneurs who operate in rich digital ecosystems characterized by advanced digital infrastructure, vibrant knowledge networks, and supportive institutional frameworks are systematically better positioned to sense market changes, seize emerging opportunities, and reconfigure their resources in response to dynamic competitive conditions.

The substantial direct effect of digital innovation ecosystems on entrepreneurial performance ($\beta = 0.421$) underscores the systemic importance of ecosystem-level factors in shaping entrepreneurial outcomes, beyond the individual-level capabilities of the entrepreneur. This aligns with Adner's (2017) ecosystem-as-structure perspective, which emphasizes that value creation in the digital economy is fundamentally a collective achievement shaped by the quality and density of interdependencies among ecosystem actors.

2. The Mediating Role of Opportunity Recognition

The significant mediating role of opportunity recognition ($\beta_{\text{indirect}} = 0.196$) highlights the cognitive and behavioral mechanisms through which digital ecosystems enhance entrepreneurial performance. This finding extends the theoretical work of Ardichvili et al. (2003) and Shane and Venkataraman (2000) by demonstrating that digital ecosystems systematically enhance entrepreneurs' alertness to profit opportunities and their capacity to recognize and evaluate viable business ideas.

Specifically, the rich information flows, knowledge spillovers, and collaborative networks characteristic of digital innovation ecosystems appear to significantly lower the cognitive costs of opportunity recognition while simultaneously expanding the range of opportunities accessible to entrepreneurs. This is consistent with Nambisan's (2017) argument that digital technologies fundamentally alter the nature of opportunity creation and enactment in the entrepreneurial process, enabling entrepreneurs to iteratively co-create and refine opportunities in interaction with customers, partners, and complementors.

The finding also has implications for entrepreneurship education and training programs. Efforts to develop entrepreneurs' opportunity recognition capabilities including design thinking workshops, customer discovery methodologies, and lean startup practices are likely to be more effective when embedded within supportive digital ecosystem contexts that provide real-time market signals and collaborative learning opportunities.

3. The Mediating Role of Technology Adoption

The significant indirect effect of digital innovation ecosystems on entrepreneurial performance through technology adoption ($\beta_{\text{indirect}} = 0.151$) reinforces the central role of technology in modern entrepreneurship. This result is consistent with the extended TAM framework (Venkatesh et al., 2019) and the empirical findings of Elia et al. (2020) and Williams et al. (2021), who demonstrated that digital technology adoption is a key predictor of SME performance in the digital era.

Importantly, the mediating role of technology adoption suggests that digital ecosystems do not automatically translate into superior performance outcomes. Rather, entrepreneurs must actively engage with and adopt the digital technologies available within their ecosystem context in order to realize performance benefits. This finding has important practical implications, suggesting that policy interventions aimed at building digital ecosystems should be complemented by capacity-building programs that support entrepreneurs in evaluating, selecting, and implementing appropriate digital solutions for their specific business contexts.

The relatively smaller magnitude of the technology adoption pathway ($\beta_{\text{indirect}} = 0.151$) compared to the opportunity recognition pathway ($\beta_{\text{indirect}} = 0.196$) may reflect the fact that, in the Indonesian SME context, technology adoption often follows opportunity recognition rather than preceding it. Entrepreneurs typically identify a market opportunity first and then seek out the digital tools needed to pursue it, rather than adopting technology speculatively in anticipation of future opportunities. This sequential pattern merits further investigation through longitudinal research designs.



4. Theoretical and Practical Implications

From a theoretical standpoint, this study makes several contributions. First, it extends dynamic capabilities theory to the digital entrepreneurship context by identifying opportunity recognition and technology adoption as specific sensing and seizing mechanisms through which digital ecosystems enhance entrepreneurial performance. Second, it integrates ecosystem-level and individual-level perspectives on digital entrepreneurship, demonstrating that the relationship between digital environments and entrepreneurial outcomes is complex, mediated, and context-dependent. Third, it adds to the growing literature on digital entrepreneurship in emerging economies (Autio et al., 2018; Liao et al., 2021) by providing empirical evidence from the Indonesian context.

From a practical standpoint, the findings offer several actionable recommendations. For entrepreneurs, the results suggest that actively engaging with digital ecosystems by participating in industry networks, digital communities, and platform ecosystems can significantly enhance their opportunity recognition capabilities and technology adoption propensity, leading to superior performance outcomes. For policymakers, the findings underscore the importance of investing in digital infrastructure, supporting knowledge networks (e.g., university-industry collaborations, innovation clusters), and designing institutional frameworks that facilitate access to digital technologies for SMEs. For ecosystem orchestrators including platform providers, industry associations, and incubators the results highlight the value of designing ecosystem services that specifically target entrepreneurs' opportunity recognition and technology adoption processes.

Beyond the three theoretical contributions outlined above, this study extends the theoretical conversation in three further respects. First, by empirically demonstrating that opportunity recognition and technology adoption operate as parallel, non-competing mediating mechanisms rather than a single unified pathway, the study offers a more fine-grained specification of dynamic capabilities theory's sensing and seizing constructs than has typically been tested in prior digital entrepreneurship research, which has often treated these capabilities as a composite whole rather than empirically distinguishing their separate transmission channels. Second, the finding that the direct effect of digital innovation ecosystems on entrepreneurial performance ($\beta = 0.421$) remains significant even after accounting for both mediators indicates that ecosystems confer performance benefits through additional pathways not captured by opportunity recognition or technology adoption alone for instance, through legitimacy, access to finance, or risk-sharing mechanisms an observation that opens a concrete avenue for future theory-building on ecosystem-performance linkages. Third, by integrating dynamic capabilities theory with the Technology Acceptance Model within a single mediated structural model, this study responds to recent calls in the entrepreneurship literature for greater theoretical integration across the strategic management and information systems traditions, rather than treating these as parallel, non-intersecting streams of inquiry. These findings translate into concrete, stakeholder-specific recommendations.

For entrepreneurs. First, entrepreneurs are encouraged to move beyond passive digital infrastructure use toward active participation in the collaborative and knowledge-sharing dimensions of their local digital ecosystem for example, by joining sector-specific digital business communities, participating in university-industry knowledge-exchange programs, and engaging with platform-based customer feedback mechanisms as it is specifically this active engagement, rather than mere access, that appears to drive the opportunity recognition and technology adoption gains identified in this study. Entrepreneurs should also treat technology adoption decisions as opportunity-driven rather than technology-driven, prioritizing digital tools that address a clearly identified market opportunity over the speculative adoption of trending technologies.

For policymakers. Second, policymakers should recognize that infrastructure investment alone is insufficient to translate digital ecosystem development into entrepreneurial performance gains. The results

suggest that public investment should be balanced across all three ecosystem dimensions examined in this study: digital infrastructure, knowledge networks, and institutional support, with particular attention to knowledge-network-building initiatives such as university-industry liaison offices, sector-specific innovation clusters, and structured mentorship programs, since these are the mechanisms through which entrepreneurs convert ecosystem access into recognized opportunities. Policymakers designing digital economy strategies, such as Indonesia's National Digital Economy Strategy, should further consider embedding opportunity-recognition and technology-adoption capacity-building components directly into SME digitalization programs, rather than funding digital infrastructure or connectivity subsidies in isolation.

For SME practitioners and ecosystem orchestrators. Third, SME support practitioners, including business incubators, accelerators, industry associations, and platform providers acting as ecosystem orchestrators, should design services that explicitly target the two mediating mechanisms identified in this study. Concretely, this could include structured opportunity-scouting workshops that pair entrepreneurs with mentors and customers to validate business ideas, and technology-adoption clinics that provide hands-on, low-risk trials of relevant digital tools (e.g., e-commerce, CRM, or digital payment platforms) before requiring financial commitment. Because the mediation results indicate partial, rather than full, mediation, practitioners should also continue to support the direct, non-mediated pathways through which digital ecosystems benefit entrepreneurs, such as facilitating access to ecosystem-based financing and peer-to-peer risk-sharing arrangements.

CONCLUSIONS

This study examined the relationship between digital innovation ecosystems and entrepreneurial performance, with opportunity recognition and technology adoption as mediating mechanisms. Based on a PLS-SEM analysis of 312 SME owners and managers in Indonesia, the findings confirmed all seven hypotheses, establishing that: (1) digital innovation ecosystems significantly and positively influence entrepreneurial performance both directly and indirectly; (2) opportunity recognition and technology adoption both significantly mediate this relationship; and (3) the combined indirect effects of these two mediators ($\beta_{\text{total indirect}} = 0.347$) account for approximately 45% of the total effect of digital innovation ecosystems on entrepreneurial performance.

These findings carry significant implications for theory, practice, and policy. Theoretically, the study advances our understanding of the mechanisms through which digital ecosystems shape entrepreneurial outcomes, providing empirical support for an integrated model that bridges ecosystem-level and individual-level perspectives. Practically, the results offer guidance to entrepreneurs, policymakers, and ecosystem orchestrators seeking to harness digital innovation for sustainable SME growth.

Several limitations of this study should be acknowledged. First, the cross-sectional design precludes causal inferences about the temporal dynamics of the relationships examined. Future research should employ longitudinal designs to trace how digital ecosystem embeddedness evolves over time and how it affects entrepreneurial trajectories. Second, the study's focus on Indonesia limits the generalizability of the findings to other emerging economy contexts. Comparative cross-national research would be valuable in establishing the boundary conditions of the proposed model. Third, the self-report nature of the survey data introduces potential common method variance, though several remedial measures were applied to mitigate this concern.

Future research should explore the moderating roles of factors such as entrepreneurial orientation, social capital, and industry-specific dynamism in shaping the ecosystem-performance relationship. Additionally, qualitative and mixed-methods approaches would provide richer insights into the lived



experiences of entrepreneurs navigating digital ecosystems and the nuanced ways in which they recognize opportunities and adopt technologies within these complex, multifaceted environments.

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