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Digital Entrepreneurship, Innovation, and Technology Adoption: Evidence from Individual-Level GEM Indonesia Data

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Abstract: *This study examines the relationships among Entrepreneurial Ecosystem, Digital Entrepreneurship, Innovation, Technology Adoption, and Entrepreneurial Growth Orientation in Indonesia. Using data from the Global Entrepreneurship Monitor (GEM) Indonesia Adult Population Survey 2022, 421 respondents were selected from 2,600 observations and analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 4. The analysis investigates direct, indirect, and moderating relationships among the five constructs. The findings indicate that Entrepreneurial Ecosystem and Digital Entrepreneurship have no statistically significant direct relationships with the proposed outcomes. Innovation is negatively associated with Technology Adoption ($\beta = -0.378$, $p < 0.001$), while Technology Adoption is negatively associated with Entrepreneurial Growth Orientation ($\beta = -0.270$, $p < 0.001$). However, Innovation demonstrates a significant positive indirect relationship with Entrepreneurial Growth Orientation through Technology Adoption ($\beta = 0.102$, $p = 0.002$), whereas all proposed moderating effects are statistically non-significant. The model exhibits limited explanatory power, with R^2 values ranging from 0.010 to 0.143, alongside measurement limitations affecting selected constructs. These findings highlight the importance of distinguishing innovation from technological implementation and entrepreneurial growth aspirations. The study contributes exploratory evidence on digital entrepreneurial dynamics in Indonesia while emphasizing the need for improved measurement and productive technology utilization.*

Keywords: Digital Entrepreneurship; Entrepreneurial Ecosystem; Entrepreneurial Growth Orientation; Innovation; Technology Adoption.

JEL : A1; E6; O3

1. INTRODUCTION

Digital transformation has widened entrepreneurial opportunities, supported by 5.35 billion internet users and 5.04 billion social media users globally (DataReportal, 2024). Digital entrepreneurship can contribute to innovation and Sustainable Development Goals 8, 9, and 17 (Fernandes, Pires, & Alves, 2023). Yet digital technologies generate value within institutional, market, and social contexts rather than independently of them (George, Merrill, & Schillebeeckx, 2021). Whether digital participation becomes entrepreneurial development consequently remains an empirical question.

Indonesia demonstrates this tension. Despite expanding digital markets, small enterprises encounter infrastructure limitations and uneven digital capabilities (Krismajayanti, Darma, Mahyuni, & Martini, 2024). Entrepreneurial perceptions and success are also shaped by ecosystem conditions (Faizah, Effendi, & Ghofar, 2024). OECD (2024) identifies weaknesses in fixed broadband, digital skills, and business adoption, while Tambunan and Busnetti (2024) document persistent digitalization gaps among Indonesian micro and small enterprises. The issue is therefore not simply whether entrepreneurs can access digital tools, but whether their use accompanies innovation and stronger growth orientation.

Table 1. Entrepreneurial Motivation in Indonesia Based on GEM 2022

Motivational		
(Somewhat or strongly agree)	% TEA	Rank/49
To make a difference in the world	48.5	23
To build great wealth or very high income	81.6	5
To continue a family tradition	31.0	21
To earn living because jobs are scarce	80.6	14

Source: Global Entrepreneurship Monitor 2022/2023 Global Report

The Global Entrepreneurship Monitor (GEM) 2022/2023 report adds a relevant distinction between entrepreneurial aspirations and capabilities (Hill et al., 2023). Table 1 shows that 81.6% of Indonesia's early-stage entrepreneurs cite wealth creation and 80.6% cite scarce jobs, whereas 48.5% seek to make a difference. These aggregate, non-exclusive motivations provide contextual evidence rather than indicators in the structural model. Nevertheless, they establish the importance of examining whether economically motivated entrepreneurial activity corresponds with innovative and technology-enabled growth orientation. Earlier evidence links innovation and perceived opportunities to business growth (Pawitan, Nawangpalupi, Olcay, & Kunday, 2021), while social capital can mitigate institutional constraints (Hanoteau, Pawitan, & Nawangpalupi, 2022).

Research gaps become clearer when prior findings are compared. Using national indicators, Pawitan, Nawangpalupi, and Widyarini (2017) reported that entrepreneurial goal orientation was positively related to national competitiveness despite negative associations for several other entrepreneurial-spirit dimensions. Pawitan, Widyarini, and Nawangpalupi (2019) identified R&D transfer and infrastructure as important ecosystem pillars of national competitiveness, whereas Pawitan, Nawangpalupi, and Tuan (2019) found that ecosystem priorities differed between nascent and established entrepreneurs. These studies illuminate national conditions and entrepreneurial stages but not joint individual-level digital pathways. More recently, Affandi, Ridhwan, Trinugroho, and Hermawan Adiwibowo (2024), surveying 5,035 Indonesian enterprises, associated digital adoption positively with business performance. Thaha, Antoro, Salmon, and Purnamasari (2024), examining 300 microenterprises, identified technological, organizational, and environmental factors associated with adoption. The former addresses realized business performance; the latter explains adoption determinants. Neither tests how innovation, adoption, ecosystem perceptions, and digital entrepreneurship jointly relate to individual growth orientation through indirect and interaction pathways.

Conceptual frameworks also differ in explanatory focus. Ecosystem research concerns interdependent institutions, resources, and networks (Stam, 2015; Spigel, 2017; Sussan & Acs, 2017); technology-acceptance models explain adoption determinants (Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). Digital entrepreneurship scholarship investigates digitally enabled opportunity creation (Nambisan, 2017; Zaheer, Breyer, & Dumay, 2019), while innovation concerns novel or improved products and processes (OECD/Eurostat, 2018). Their different constructs should not be presumed interchangeable.

Accordingly, this study tests an Ecosystem-Based Digital Dynamics Model using 421 individual observations from GEM Indonesia's 2022 Adult Population Survey. Its contribution is to distinguish ecosystem perceptions, digital entrepreneurial activity, innovation, and technology adoption within one respondent-level framework and assess direct, indirect, and interaction patterns rather than assuming uniformly beneficial digital effects. Three questions guide the analysis: (1) How are the five constructs directly associated? (2) Is Innovation indirectly associated with Entrepreneurial Growth Orientation through Technology Adoption? (3) Does Innovation moderate the relationships of Digital Entrepreneurship and Technology Adoption with growth orientation, and does Technology Adoption moderate the Digital Entrepreneurship–growth orientation relationship? Cross-sectional estimates are interpreted as statistical associations, not causal effects.

2. LITERATURE REVIEW

2.1. Entrepreneurial Ecosystem

Entrepreneurial ecosystems comprise interacting actors, institutions, and resources (Reynolds et al., 2005; Bosma, 2013). Stam and van de Ven (2021) emphasize interdependence, while institutional legitimacy and culture shape opportunities (Stephan, Uhlaner, & Stride, 2015; Audretsch, Belitski, Eichler, & Schwarz, 2024). Relational and digital perspectives further highlight resource connections (Spigel, 2017; Wurth, Stam, & Spigel, 2022; Bouncken & Kraus, 2022). Surveying 5,035 enterprises across 17 Indonesian provinces, Affandi et al. (2024) identified adoption disparities associated with infrastructure and business conditions. Ecosystem availability therefore differs from entrepreneurs' capacity to utilize it.

2.2. Digital Entrepreneurship

Digital entrepreneurship uses technology to identify opportunities and create value (Autio, 2017; Nambisan, 2017; Kraus, Palmer, Kailer, Kallinger, & Spitzer, 2019; Paul, Alhassan, Binsaif, & Singh, 2023). Its effects depend on place, capabilities, and experimentation (Reuschke, Mason, & Syrett, 2022; Bermann, Stuckler, Schallmo, & Kraus, 2024; Lamine, Fayolle, Jack, & Audretsch, 2023; Steininger, Brohman, & Block, 2022; Felicetti, Corvello, & Ammirato, 2024; Sahi, Khalid, Abbas, & Khatib, 2026). Among 129 Bandung enterprises, Ningsih, Priscilla, and Kaltum (2024) found that digitalization and innovation capabilities positively related to performance. Their outcome, however, differs from prospective growth orientation.

2.3. Innovation

Innovation concerns novel products, services, and processes rather than technological use itself (Koellinger, 2008; Baines, Klangboonkrong, & Lawton Smith, 2024; Zhang, Garrett, Liang, & Zhang, 2021). Among 107 enterprises in Malang, Yulianto and Supriono (2023) found that open innovation supported product, service, and process innovation without a significant direct performance effect. Innovation may require new technology, but experimentation and implementation compete for limited resources. Such tensions offer a plausible, unverified explanation for negative innovation–adoption associations.

2.4. Technology Adoption

Technology adoption is the application of technologies in entrepreneurial activities (Bosma et al., 2021). Its determinants include compatibility, readiness, infrastructure, and supporting conditions (Zamani, Smyth, & Ali, 2022; Santini, de Matos, Ladeira, Jardim, & Perin, 2023; Omrani, Rejeb, Maalaoui, Dabić, & Kraus, 2024; Faiz, 2024). Studying 300 Indonesian microenterprises, Thaha et al. (2024) identified technological, organizational, and environmental adoption factors. Adoption may enable value creation but does not automatically establish growth outcomes.

2.5. Entrepreneurial Growth Orientation

Entrepreneurial Growth Orientation addresses forward-looking development rather than observed national growth. Employment expectations express economic ambition (Wong, Ho, & Autio, 2005; Haltiwanger, Jarmin, & Miranda, 2013); environmental and social priorities reflect sustainable entrepreneurship (Cohen & Winn, 2007; Belz & Binder, 2017; Mair & Martí, 2006). Among 119 Jakarta creative-economy enterprises, Kurniawan and Selamat (2023) associated sustainability orientation with sustainable entrepreneurship through entrepreneurial bricolage. GEM indicators concerning job creation, environmental impacts, sustainability priorities, and social considerations may represent dimensions of responsible growth orientation. However, shared conceptual relevance does not establish a single reflective construct; measurement specification and validity must be assessed.

2.6. Conceptual Framework

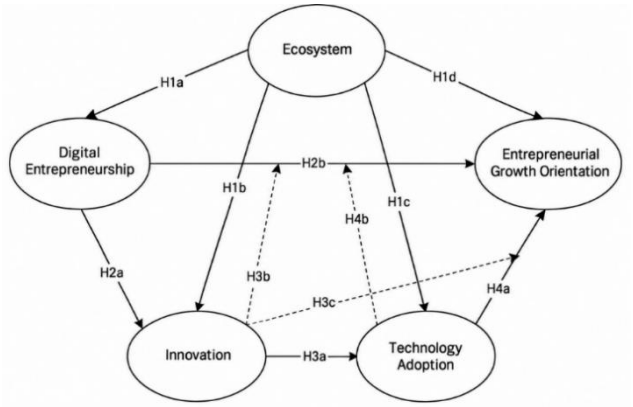

Figure 1. Conceptual Framework
Source: Author's Analysis

The framework distinguishes entrepreneurial environment from digital activities, innovation, technology adoption, and individual growth orientation (Ali & Jabeen, 2024; Marinelli, Bartoloni, Costa, & Pascucci, 2023; Felicetti et al., 2024; Lado, Castro-Abancens, Moreno-Menéndez, & Casillas, 2024; Ndofirepi & Steyn, 2024). Although entrepreneurship also relates to sustainable development (Elmonshid & Sayed, 2024), national growth is not directly measured here.

2.7. Hypothesis Development

2.7.1. Entrepreneurial Ecosystem Relationships

Institutional support may promote Digital Entrepreneurship through networks, Innovation through knowledge sharing, and Technology Adoption through infrastructure (Bosma, 2013; Stam & van de Ven, 2021; Marinelli et al., 2023; Ali & Jabeen, 2024). Greater resource access may also strengthen Entrepreneurial Growth Orientation. Nevertheless, regional differences observed by Affandi et al. (2024) suggest that perceived support does not guarantee effective utilization. These arguments support four testable expectations:

- *H1a: Entrepreneurial Ecosystem has a positive relationship with Digital Entrepreneurship.*
- *H1b: Entrepreneurial Ecosystem has a positive relationship with Innovation.*
- *H1c: Entrepreneurial Ecosystem has a positive relationship with Technology Adoption.*
- *H1d: Entrepreneurial Ecosystem has a positive relationship with Entrepreneurial Growth Orientation.*

2.7.2. Digital Entrepreneurship Relationships

Digital channels provide feedback and experimentation opportunities, potentially supporting Innovation; wider customer access may encourage Entrepreneurial Growth Orientation (Steininger et al., 2022; Felicetti et al., 2024). Evidence from Bandung links digitalization and innovation capabilities to business performance (Ningsih et al., 2024), but does not establish the proposed individual-level associations:

- *H2a: Digital Entrepreneurship has a positive relationship with Innovation.*
- *H2b: Digital Entrepreneurship has a positive relationship with Entrepreneurial Growth Orientation.*

2.7.3. Innovation Relationships and Moderating Role

Novel products or processes may require technology integration, supporting a positive Innovation–Technology Adoption association (Koellinger, 2008; Baines et al., 2024). Yet different innovation types produce different outcomes (Yulianto & Supriono, 2023), and scarce resources can impede adoption. Innovation may also moderate two relationships:

differentiated offerings could strengthen the link between Digital Entrepreneurship and Entrepreneurial Growth Orientation; innovative applications could strengthen the link between Technology Adoption and Entrepreneurial Growth Orientation. In Bali, Muna, Subawa, Suardana, and Lasmi (2025) associated social-media adoption with innovation quality and business performance, providing complementarity evidence, not direct confirmation of moderation.

- *H3a: Innovation has a positive relationship with Technology Adoption.*
- *H3b: Innovation positively moderates the relationship between Digital Entrepreneurship and Entrepreneurial Growth Orientation.*
- *H3c: Innovation positively moderates the relationship between Technology Adoption and Entrepreneurial Growth Orientation.*

2.7.4. Technology Adoption Relationships and Moderating Role

Technology Adoption may support entrepreneurial aspirations through efficiency and market access (Omrani et al., 2024; Faiz, 2024). Affandi et al. (2024) found positive adoption–performance associations; among 330 East Java businesses, Prakasa and Jumani (2024) found digital transformation mediated the digital capability–performance relationship. Neither establishes moderation. The proposed interaction instead tests whether Digital Entrepreneurship is more strongly associated with Entrepreneurial Growth Orientation when Technology Adoption is higher.

- *H4a: Technology Adoption has a positive relationship with Entrepreneurial Growth Orientation.*
- *H4b: Technology Adoption positively moderates the relationship between Digital Entrepreneurship and Entrepreneurial Growth Orientation.*

3. METHODOLOGY

3.1. Research Design

This study employs a quantitative explanatory research design using secondary data from the 2022 Adult Population Survey (APS) of the Global Entrepreneurship Monitor (GEM) Indonesia. The analysis examines statistical relationships among five constructs: Entrepreneurial Ecosystem, Digital Entrepreneurship, Innovation, Technology Adoption, and Entrepreneurial Growth Orientation. The unit of analysis is the individual respondent rather than the enterprise or national economy.

The GEM APS provides standardized information regarding entrepreneurial activities, perceptions, technological practices, and business aspirations (Hill et al., 2023). Because the research uses cross-sectional data, structural relationships are interpreted as statistical associations rather than causal effects.

3.2. Data Sources and Sample Selection

The original GEM Indonesia APS 2022 dataset comprised 2,600 observations. Sample selection applied two screening variables: BSTART (Business Start) and BJOBST (Business Job Start). BSTART identifies respondents attempting to establish a business, whereas BJOBST identifies respondents attempting to initiate a business or venture for their employer. Both variables were used to construct a purposive analytical subsample of individuals reporting these entrepreneurial initiation activities.

The inclusion criteria required affirmative responses (coded 1) to both BSTART and BJOBST. Respondents reporting negative responses, uncertainty, or refusal on either screening variable were excluded. The first screening retained 820 respondents with BSTART = 1, excluding 1,780 observations. Among these 820 respondents, 421 also satisfied BJOBST = 1, while 399 were excluded. Therefore, the final analytical sample comprised 421 respondents, representing 16.2% of the original dataset.

Table 2. Sample Selection Procedure

Selection Stage	Retained	Excluded
Initial GEM Indonesia APS 2022	2,600	—
BSTART = 1	820	1,780
BSTART = 1 and BJOBST = 1	421	399
Final analytical sample	421	—

Source: *Authors' analysis of GEM Indonesia APS 2022.*

The resulting sample represents respondents satisfying the study-specific screening criteria rather than the entire officially classified Total Early-stage Entrepreneurial Activity (TEA) population. Verification using GEM classification variables identified 155 TEA respondents, comprising 78 nascent entrepreneurs and 77 new business owner-managers. The remaining 266 respondents were not classified as TEA.

Demographic analysis of the 421 selected respondents identified 209 males (49.6%) and 212 females (50.4%). Respondents were aged 19–64 years, with an average age of approximately 42 years. The largest age group was 35–44 years (31.8%), followed by 45–54 years (26.6%) and 25–34 years (20.4%). Regarding education, 41.6% had completed secondary education, 24.7% had some secondary education, and 16.4% had post-secondary education. Six respondents had education codes that could not be classified.

Geographically, respondents originated from 18 Indonesian provinces. West Java contributed the largest number (79), followed by East Java (63), Central Java (52), and North Sumatra (51). These characteristics describe the selected analytical sample rather than the full Indonesian entrepreneurial population.

Although the original GEM APS 2022 dataset includes survey-weighting variables, the present study employed unweighted data for the PLS-SEM analysis. Consequently, the findings primarily reflect the relationships observed within the selected sample of 421 respondents and should be interpreted cautiously when considering their generalizability to the broader Indonesian entrepreneurial population.

3.3. Variable Operationalization

Five constructs were operationalized using indicators derived from the GEM Indonesia APS 2022 questionnaire. The variables cover entrepreneurial perceptions, digital activities, innovation, technological utilization, and growth-related orientations.

Table 3. Variable Operationalization

Construct	Dimensions	GEM Indicators
Entrepreneurial Ecosystem	Social and cultural context; national framework conditions; entrepreneurial opportunities	NBSTATUS, NBMEDIA, EASYSTART, NBGOODC
Digital Entrepreneurship	Digital entrepreneurial opportunities and practices	OMCRTECH1, OMCRTECH2
Innovation	Product, service, and process novelty	SUNEWPROD, TEANEWPROD, SUNEWPROC, TEANEWPROC
Technology Adoption	New technology or process utilization; digital technology support	TEACPTECH1, TEACPTECH2, SUPTECH1, SUPTECH2
Entrepreneurial Growth	Job creation;	TEAJOBGR, SUSDG_ENV,

Orientation	environmental impact; sustainability priorities; social impact	SUSDG_PRI, SUSDG_SOC

Source: *Adapted from Reynolds et al. (2005), Bosma (2013), Autio (2017), Koellinger (2008), Bosma et al. (2021), and Wong, Ho, and Autio (2005); operational indicators derived from GEM APS 2022.*

The GEM APS 2022 indicators were coded numerically according to their original response categories for PLS-SEM analysis. Entrepreneurial Ecosystem and sustainability indicators used five-point ordinal scales, while Innovation employed four categories reflecting product and process novelty. Digital Entrepreneurship and Technology Adoption used categorical measures of technological practices and intentions, whereas TEAJOBGR represented numerical job-growth expectations. Nonresponse codes were treated separately from valid responses. The analytical dataset comprised 421 respondents and 25 variables, including 18 measurement indicators, selected from 2,600 observations using BSTART and BJOBST to examine relationships among the five proposed constructs.

3.4. Data Analysis Method

This study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 4 to examine direct, indirect, and moderating relationships among the five constructs (Hair, Hult, Ringle, & Sarstedt, 2022). The method was selected for its suitability in examining multiple structural relationships and constructs measured through diverse indicators.

The measurement model was evaluated using outer loadings, Cronbach's alpha, composite reliability, Average Variance Extracted, and the Heterotrait–Monotrait ratio for reflective constructs. Structural relationships were assessed through R^2, f^2, path coefficients, indirect effects, and moderating effects. Hypothesis testing employed 5,000 bootstrap subsamples at a 5% significance level, with a two-tailed critical value of 1.96. The findings were interpreted as statistical associations within the selected GEM Indonesia sample.

4. RESULTS AND DISCUSSION

4.1. Results

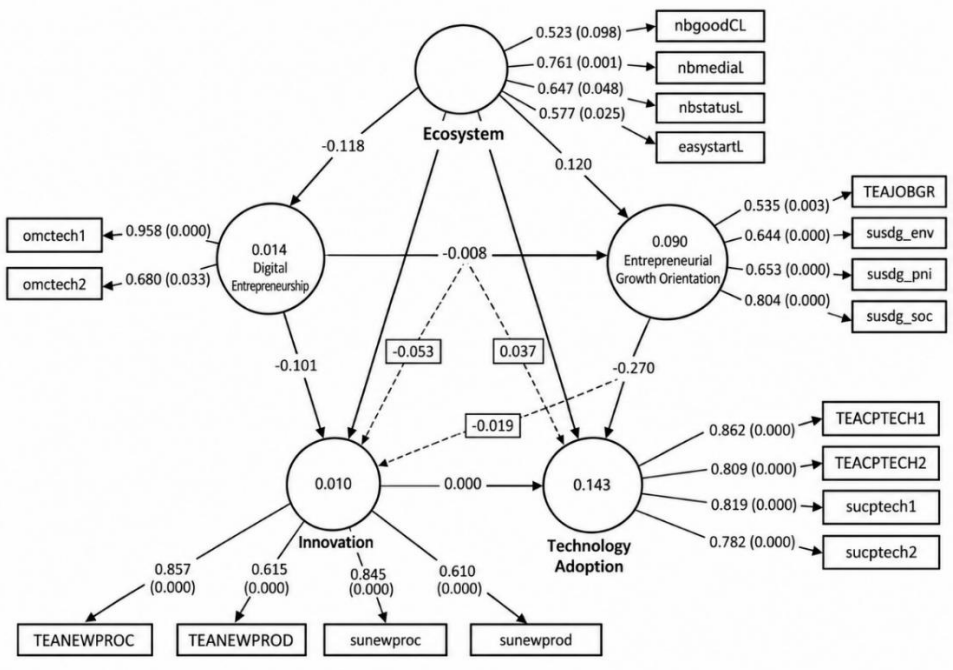

Figure 2. Outer Loadings and Bootstrapping Results
Source: Smart PLS 4

Following data cleaning and filtering, 421 of the initial 2,600 GEM Indonesia observations met the study criteria and were retained for analysis. The selected indicators were analyzed using SmartPLS 4 through measurement-model assessment, followed by structural-model evaluation.

Table 4. Measurement Model Reliability, Validity, and Explanatory Power

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)	R^2
Entrepreneurial Ecosystem	0,512	0,527	0,724	0,401	—
Digital Entrepreneurship	0,613	1,006	0,813	0,691	0,014
Innovation	0,755	0,821	0,826	0,550	0,010
Technology Adoption	0,837	0,848	0,890	0,670	0,143
Entrepreneurial Growth Orientation	0,680	0,677	0,807	0,518	0,090

Source: Smart PLS 4

Table 4 indicates that the measurement model does not consistently meet reliability and validity criteria. Entrepreneurial Ecosystem exhibits low internal consistency (Cronbach's alpha = 0.512) and insufficient convergent validity (AVE = 0.401), suggesting limited consistency among its indicators and an inadequate proportion of explained indicator variance. Digital Entrepreneurship also falls below the conventional reliability threshold (alpha = 0.613), while its rho_a value of 1.006 exceeds the admissible range, indicating a potential estimation or measurement-specification problem. Although both constructs demonstrate acceptable composite reliability (rho_c), these values do not eliminate the identified deficiencies. Entrepreneurial Growth Orientation shows marginal internal consistency (alpha = 0.680), whereas Innovation and Technology Adoption satisfy the conventional criteria. Consequently, structural estimates involving the weaker constructs may be affected by measurement error and should be interpreted cautiously (Hair & Alamer, 2022).

Discriminant validity was assessed using the Heterotrait–Monotrait ratio (HTMT). All reported values were below 0.90, with the highest value of 0.542, indicating adequate construct differentiation. However, acceptable discriminant validity does not compensate for insufficient internal consistency or convergent validity.

The structural model demonstrates limited explanatory power. Technology Adoption has the highest R^2 (0.143), followed by Entrepreneurial Growth Orientation (0.090), Digital Entrepreneurship (0.014), and Innovation (0.010). Thus, the model explains only 14.3%, 9.0%, 1.4%, and 1.0% of their respective variances, indicating that most variation remains unexplained. Innovation → Technology Adoption has the largest reported effect size ($f^2 = 0.167$), followed by Technology Adoption → Entrepreneurial Growth Orientation ($f^2 = 0.054$), while the remaining effects are relatively small. Accordingly, the model provides limited explanatory evidence and should be interpreted as exploratory rather than as demonstrating strong predictive performance.

4.2. Findings

Table 5. Results of Direct, Indirect, and Moderating Effect Hypothesis Testing

Type	Hypothesis	Relationship Path	Original Sample (O)	T statistics	P-Values	Conclusion
Direct	H1a	Entrepreneurial Ecosystem → Digital Entrepreneurship	-0.118	1.341	0.180	Non-significant; hypothesis not supported
Direct	H1b	Entrepreneurial Ecosystem → Innovation	-0.008	0.081	0.935	Non-significant; hypothesis not supported
Direct	H1c	Entrepreneurial Ecosystem → Technology Adoption	-0.015	0.248	0.804	Non-significant; hypothesis not supported
Direct	H1d	Entrepreneurial Ecosystem → Entrepreneurial Growth Orientation	0.120	1.220	0.222	Non-significant; hypothesis not supported
Direct	H2a	Digital Entrepreneurship → Innovation	-0.101	1.370	0.171	Non-significant; hypothesis not supported
Direct	H2b	Digital Entrepreneurship → Entrepreneurial Growth Orientation	-0.003	0.075	0.940	Non-significant; hypothesis not supported
Direct	H3a	Innovation → Technology Adoption	-0.378	8.070	<0.001	Significant negative relationship; hypothesized positive relationship not supported
Direct	H4a	Technology Adoption → Entrepreneurial Growth Orientation	-0.270	3.594	<0.001	Significant negative relationship; hypothesized positive relationship

						not supported
Direct	Additional analysis	Innovation → Entrepreneurial Growth Orientation	-0.087	0.715	0.475	Non-significant; additional direct relationship not supported
Indirect	Additional analysis	Entrepreneurial Ecosystem → Technology Adoption	-0.002	0.444	0.965	Non-significant; indirect relationship not supported
Indirect	Additional analysis	Entrepreneurial Ecosystem → Innovation	0.012	0.823	0.411	Non-significant; indirect relationship not supported
Indirect	Additional analysis	Entrepreneurial Ecosystem → Entrepreneurial Growth Orientation	0.004	0.192	0.848	Non-significant; indirect relationship not supported
Indirect	Additional analysis	Innovation → Technology Adoption → Entrepreneurial Growth Orientation	0.102	3.119	0.002	Significant positive indirect relationship; indirect effect supported
Indirect	Additional analysis	Digital Entrepreneurship → Technology Adoption	0.038	1.286	0.198	Non-significant; indirect relationship not supported
Indirect	Additional analysis	Digital Entrepreneurship → Entrepreneurial Growth Orientation	-0.002	0.111	0.912	Non-significant; indirect relationship not supported
Moderating	H3b	Innovation × Digital Entrepreneurship → Entrepreneurial Growth	-0.053	0.547	0.584	Non-significant; hypothesized positive moderating relationship

		Orientation				not supported
Moderating	H3c	Innovation × Technology Adoption → Entrepreneurial Growth Orientation	-0.019	0.226	0.822	Non-significant; hypothesized positive moderating relationship not supported
Moderating	H4b	Technology Adoption × Digital Entrepreneurship → Entrepreneurial Growth Orientation	0.037	0.646	0.518	Non-significant; hypothesized positive moderating relationship not supported

Source: Smart PLS 4

Table 5 shows that two direct relationships are statistically significant: Innovation → Technology Adoption (β = -0.378, p < 0.001) and Technology Adoption → Entrepreneurial Growth Orientation (β = -0.270, p < 0.001). However, both relationships contradict their hypothesized positive directions; therefore, H3a and H4a are not supported. The remaining direct relationships are non-significant.

The indirect analysis identifies a significant positive relationship between Innovation and Entrepreneurial Growth Orientation through Technology Adoption (β = 0.102, p = 0.002), while the other reported indirect relationships are non-significant. Furthermore, none of the three moderating effects is statistically significant, indicating that H3b, H3c, and H4b are not supported.

4.3. Discussion

1. **Direct Relationships Among Entrepreneurial Ecosystem, Digital Entrepreneurship, Innovation, and Technology Adoption**

   The first research question examines the direct relationships among Entrepreneurial Ecosystem, Digital Entrepreneurship, Innovation, Technology Adoption, and Entrepreneurial Growth Orientation. Entrepreneurial Ecosystem shows no significant relationships with the endogenous constructs, differing from studies emphasizing institutional support, infrastructure, and entrepreneurial networks (Reynolds et al., 2005; Bosma, 2013; Stam & van de Ven, 2021; Stephan, Uhlaner, & Stride, 2015; Audretsch, Belitski, Eichler, & Schwarz, 2024; Marinelli, Bartoloni, Costa, & Pascucci, 2023). Ecosystem contributions may depend on resource utilization and interactions among entrepreneurial actors (Wurth, Stam, & Spigel, 2022), particularly in Indonesia, where infrastructure, digital literacy, and institutional constraints remain relevant (Faizah et al., 2024; Krismajayanti et al., 2024). Similarly, Digital Entrepreneurship shows no significant relationships with Innovation (β = -0.101, p = 0.171) or Entrepreneurial Growth Orientation (β = -0.003, p = 0.940), despite literature highlighting digital opportunities, innovation, and business transformation (Autio, 2017; Kraus, Palmer, Kailer, Kallinger, & Spitzer, 2019; Paul, Alhassan, Binsaif, & Singh, 2023; Lamine, Fayolle, Jack, & Audretsch, 2023; Steininger, Brohman, & Block, 2022; Felicetti, Corvello, & Ammirato, 2024; Sahi, Khalid, Abbas, & Khatib, 2026). Contextual capabilities and environmental support may influence these relationships (Bejjani et al., 2023; Bermann, Stuckler, Schallmo, & Kraus, 2024; Reuschke, Mason, & Syrett, 2022). However, the low reliability of Entrepreneurial Ecosystem and Digital Entrepreneurship limits confidence in these non-significant findings.

2. **Negative Relationships and the Indirect Role of Technology Adoption**

The second research question examines the relationships among Innovation, Technology Adoption, and Entrepreneurial Growth Orientation. Innovation shows a significant negative relationship with Technology Adoption (β = -0.378, $p < 0.001$), potentially reflecting differences between developing new products or processes and implementing digital technologies (Koellinger, 2008; Baines, Klangboonkrong, & Lawton Smith, 2024; Zhang, Garrett, Liang, & Zhang, 2021). Yulianto and Supriono (2023), studying 107 enterprises in Malang, similarly found that open innovation supported different innovation types without significantly improving firm performance directly. Limited resources, implementation costs, and organizational readiness may also influence technological investment decisions (Cunningham et al., 2023; Felicetti et al., 2024). Technology Adoption is likewise negatively associated with Entrepreneurial Growth Orientation (β = -0.270, $p < 0.001$), contrasting with literature connecting entrepreneurship with economic, environmental, and social development (Wong, Ho, & Autio, 2005; Haltiwanger, Jarmin, & Miranda, 2013; Cohen & Winn, 2007; Belz & Binder, 2017; Mair & Martí, 2006). This relationship may reflect implementation costs and differences between technological adoption and value realization, which depend on compatibility, infrastructure, and organizational capabilities (Bosma et al., 2021; Zamani, Smyth, & Ali, 2022; Santini et al., 2023; Omrani, Rejeb, Maalaoui, Dabić, & Kraus, 2024; Faiz, 2024; Kraus et al., 2021; Marinelli et al., 2023). Importantly, the negative coefficients must also be interpreted considering GEM indicators whose numerical coding may run opposite to substantive technology adoption. Meanwhile, Innovation demonstrates a significant positive indirect relationship with Entrepreneurial Growth Orientation through Technology Adoption (β = 0.102, $p = 0.002$), consistent with the interconnected nature of entrepreneurial innovation and technology (Ali & Jabeen, 2024; Felicetti et al., 2024; Lado, Castro-Abancens, Moreno-Menéndez, & Casillas, 2024; Marinelli et al., 2023; Ndofirepi & Steyn, 2024). Nevertheless, this indirect coefficient results from two negative paths and represents a statistical association rather than proven causal mediation.

3. Moderating Relationships of Innovation and Technology Adoption

The third research question examines the moderating roles of Innovation and Technology Adoption in explaining Entrepreneurial Growth Orientation. None of the proposed interactions is statistically significant, including Innovation × Digital Entrepreneurship (β = -0.053, $p = 0.584$), Innovation × Technology Adoption (β = -0.019, $p = 0.822$), and Technology Adoption × Digital Entrepreneurship (β = 0.037, $p = 0.518$). These results indicate that the hypothesized moderating relationships are not supported within the selected sample, despite previous research emphasizing the complementary roles of digital technologies, innovation, and entrepreneurial capabilities (Bejjani et al., 2023; Felicetti et al., 2024). Technology adoption and digital entrepreneurship may depend on infrastructure, technological compatibility, organizational readiness, and environmental support (Zamani et al., 2022; Santini et al., 2023; Omrani et al., 2024; Bermann et al., 2024). However, these alternative conditions were not directly tested as moderators. Therefore, the findings indicate insufficient statistical evidence for the proposed interactions rather than establishing that such relationships are absent across entrepreneurial contexts.

4. Overall Interpretation and Research Contribution

Overall, the Ecosystem-Based Digital Dynamics Model provides limited empirical support for the proposed relationships, with significant direct coefficients concentrated in Innovation → Technology Adoption and Technology Adoption → Entrepreneurial Growth Orientation. These findings complement earlier Indonesian entrepreneurship research concerning ecosystem conditions, competitiveness, and entrepreneurial development (Pawitan, Nawangpalupi, & Tuan, 2019; Pawitan, Nawangpalupi, & Widyarini, 2017; Pawitan, Widyarini, & Nawangpalupi, 2019; Pawitan et al., 2021), alongside studies emphasizing digital capabilities and entrepreneurial ecosystems (Bejjani et al., 2023; George et al., 2021; Olan et al., 2024). The study contributes by examining innovation, technological implementation, and multidimensional entrepreneurial growth orientation within an integrated individual-level framework. However, the low R^2 values, particularly for Entrepreneurial

Growth Orientation (0.090), indicate limited explanatory power, while inadequate reliability in selected constructs and heterogeneous indicator coding constrain the interpretation of structural coefficients. Consequently, the findings should be viewed as exploratory evidence concerning digital entrepreneurial dynamics rather than definitive or nationally generalizable conclusions about entrepreneurial development.

5. CONCLUSION AND SUGGESTION

CONCLUSION

This study reveals that entrepreneurial dynamics in Indonesia are not fully explained by the proposed Ecosystem-Based Digital Dynamics Model. Entrepreneurial Ecosystem and Digital Entrepreneurship show no significant direct relationships with the main outcomes, while Innovation is negatively associated with Technology Adoption, and Technology Adoption is negatively associated with Entrepreneurial Growth Orientation. However, Innovation demonstrates a significant positive indirect relationship with Entrepreneurial Growth Orientation through Technology Adoption, while all moderating effects are non-significant. These findings highlight the complexity of entrepreneurial relationships, although low explanatory power, measurement limitations, and the cross-sectional design restrict causal interpretation and generalizability.

The findings also emphasize the distinction between technology adoption and productive digital transformation. Approximately 27 million Indonesian MSMEs had adopted digital technologies by 2024 (Kementerian Komunikasi dan Informatika, 2024), while QRIS reached 39.3 million merchants, including 93.16% MSMEs (Bank Indonesia, 2025). Nevertheless, widespread adoption does not necessarily indicate improved entrepreneurial outcomes. This aligns with the UMKM Level Up Program, which emphasizes efficiency, competitiveness, innovation, and business value alongside digital adoption (Kementerian Komunikasi dan Informatika, 2024). Thus, the model offers exploratory insights rather than evidence of causal effects.

SUGGESTION

Policy initiatives should prioritize entrepreneurs' digital capabilities, innovation integration, and productive technology utilization rather than adoption rates alone. A proposed *Data-Driven Digital MSME Upgrading* approach could support targeted business mentoring using digital transaction information, including QRIS, to identify operational and development needs. This recommendation represents a potential policy application rather than an intervention tested in the study. Future research should incorporate entrepreneurial skills, financial access, human capital, infrastructure, and institutional support while improving construct measurement and employing longitudinal or comparative designs to strengthen the explanatory power and generalizability of the findings.

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