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DIGITALIZATION OF MSMEs, FINTECH ACCESS, AND DIGITAL LITERACY IN STRENGTHENING THE REGIONAL ECONOMY IN INDONESIA

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ABSTRACT

This research examines the interrelationship among MSME (Micro, Small, and Medium Enterprises) digitalization, fintech (financial technology) access, and digital literacy as pivotal enablers for strengthening regional economic resilience in Indonesia. Employing a mixed-methods approach combining structural equation modeling (SEM) on a sample of 385 MSME actors across five Indonesian provinces with qualitative interviews the research evaluates how digital adoption translates into measurable economic outcomes at the regional level. Findings reveal that digital literacy significantly mediates the relationship between fintech access and MSME performance ($\beta = 0.487$, $p < 0.001$), while infrastructure readiness moderates the digitalization-performance nexus. Regions with higher digital literacy indices demonstrate 32.4% greater MSME revenue growth compared to low-literacy regions. The research contributes a new Regional Digital Economy Strengthening (RDES) framework and provides evidence-based policy recommendations for Indonesian provincial governments and the Financial Services Authority (OJK). Implications extend to other developing economies facing similar structural digital divides.

Keywords: *MSME digitalization; fintech access; digital literacy; regional economic development; Indonesia; SEM*
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1. INTRODUCTION

Indonesia's economic landscape has undergone a profound transformation in the digital era, particularly evident in the evolution of its Micro, Small, and Medium Enterprises (MSMEs) sector. As the backbone of the national economy, MSMEs contribute approximately 60.5% of Gross Domestic Product (GDP) and absorb 97% of the total workforce (BPS, 2023). Yet, despite their macroeconomic significance, a persistent digital divide continues to constrain their growth potential, particularly in regions outside major metropolitan centers. The digital transformation of MSMEs is not merely a technological phenomenon; it represents a fundamental restructuring of how small enterprises access markets, manage finances, and integrate into broader economic value chains. Financial technology (fintech) solutions including peer-to-peer (P2P) lending platforms, digital payment systems, and mobile banking applications have emerged as transformative forces that democratize financial access for previously underbanked MSME operators (Gomber et al., 2018; Lee & Shin, 2018). Simultaneously, the level of digital literacy among MSME operators determines the extent to which these technological tools can be effectively utilized to generate economic value.

Regional economic disparities in Indonesia present a unique context for examining digital transformation. The archipelago's geographic complexity comprising over 17,000 islands across 38 provinces creates significant variations in digital infrastructure quality, fintech penetration rates, and human capital endowment. While urban centers such as DKI Jakarta demonstrate advanced digitalization metrics, peripheral regions in Eastern Indonesia continue to struggle with basic connectivity challenges. This spatial heterogeneity offers a rich natural experiment for understanding how digital factors interact to shape regional economic outcomes.

Despite growing scholarly interest in MSME digitalization (Nambisan, 2017; Maulana & Sitorus, 2022), fintech adoption (Claessens et al., 2018; Wijaya & Pratama, 2023), and digital literacy (Van Dijk, 2006; Firmansyah & Anwar, 2021), there remains a notable gap in research examining the triadic relationship among these constructs within the context of regional economic strengthening. Most existing studies adopt a dyadic approach examining digitalization-performance relationships or fintech-access relationships in isolation without accounting for the mediating role of digital literacy or the moderating influence of regional infrastructure.

This research addresses these gaps by investigating four research questions: (1) To what extent does MSME digitalization contribute to regional economic strengthening in Indonesia? (2) How does fintech access influence MSME performance, and is this relationship mediated by digital literacy? (3) What is the role of regional digital infrastructure in moderating the digitalization-performance relationship? (4) What policy interventions can effectively accelerate digital economic inclusion across Indonesian regions?

The research contributes a new Regional Digital Economy Strengthening (RDES) framework that integrates Schumpeterian innovation theory (1934), Technology Acceptance Model (Davis, 1989), Digital Capital Theory (DiMaggio & Hargittai, 2001), and Sen's (1999) capabilities approach into a unified multi-pathway analytical model. Empirical validation using 385 MSME respondents across five provinces provides the first multi-regional SEM evidence of the full mediation of fintech access by digital literacy in the Indonesian context.

2. LITERATURE REVIEW

2.1 MSME Digitalization: Theoretical Foundations and Empirical Evidence

Digitalization of MSMEs encompasses the integration of digital technologies into business processes, including e-commerce adoption, digital payment systems, cloud-based management tools, and social media marketing (Nambisan, 2017; Verhoef et al., 2021). Drawing from Schumpeter's (1934) creative destruction theory, digitalization constitutes a process innovation that enhances productive efficiency and market access, generating enterprise-level performance gains that aggregate into regional economic development through multiplier effects.

The Technology Acceptance Model (TAM, Davis, 1989) operationalizes individual adoption behavior through perceived usefulness and perceived ease of use, providing the micro-behavioral foundation for macro-level digitalization outcomes. Resource-Based View theory (Barney, 1991) complements TAM by framing digital capabilities as strategically valuable organizational resources that confer sustainable competitive advantage. In Indonesia, Maulana and Sitorus (2022) documented 24.7% average revenue increases for digitally adopted MSMEs within 18 months, while Nugroho et al. (2021) demonstrated that e-commerce participation reduces market access barriers in remote regions.

2.2 Fintech Access and Financial Intermediation Theory

Financial technology has fundamentally altered MSME financing landscapes by applying algorithmic credit assessment and digital payment infrastructure to overcome traditional banking barriers (Gomber et al., 2018). Classical financial intermediation theory (Gurley & Shaw, 1955; Levine, 1997) establishes that efficient capital allocation drives enterprise growth and aggregate development fintech operationalizes this intermediation at substantially lower cost and broader geographic reach than conventional banking.

OJK (2023) data confirms that fintech adoption rates among Indonesian MSMEs increased from 23.4% in 2017 to 58.7% in 2023. Wijaya and Pratama (2023) found that P2P lending-accessing MSMEs demonstrated 38.3% higher survival rates during economic disruptions. However, Arun and Kamath (2015) caution that fintech can paradoxically deepen exclusion through over-indebtedness and digital fraud vulnerability when deployed without accompanying digital literacy programs a theoretical proposition directly tested in H4.

2.3 Digital Literacy as Human Capital and Mediating Construct

Digital literacy, conceptualized by Van Dijk (2006) through a four-stage sequential access model (motivational, material, skills, and usage access), has emerged as a critical determinant of digital economic

outcomes. DiMaggio and Hargittai's (2001) Digital Capital Theory extends this model by framing digital literacy as a form of human capital that enables extraction of economic value from digital technologies. Sen's (1999) capabilities approach provides a development economics grounding: digital literacy constitutes the individual conversion factor that transforms digital resource access into digital economic capability.

The Indonesian National Digital Literacy Index (INDI, Kemkominfo, 2022) operationalizes digital literacy across four dimensions—digital skills, digital culture, digital ethics, and digital safety—with a 2023 national average of 52.4/100. Firmansyah and Anwar (2021) established digital literacy's mediating role in the technology-utilization relationship (mediation coefficient 0.41), while van Laar et al. (2017) synthesized evidence from 47 studies confirming 21st-century digital skills as essential prerequisites for economic value creation from digital tools.

2.4 Regional Economic Development and Digital Transformation

Regional economic development theory, grounded in Krugman's (1991) new economic geography, identifies agglomeration economies, factor mobility, and institutional quality as primary determinants of subnational economic performance. Digital transformation introduces location-independent value creation mechanisms that theoretically should reduce regional disparities; however, Rodrik (2018) argues that digital technologies may initially exacerbate inequality before convergence effects emerge, particularly in economies with significant infrastructure and human capital heterogeneity.

Bappenas (2021) projects Indonesia's digital economy contribution to increase from 4.7% of GDP in 2020 to 16% by 2030. Infrastructure theory (Teece, 1986; Czernich et al., 2011) identifies digital connectivity as the essential complementary asset for realizing digitalization economic returns, while Katz (2012) documents that broadband penetration improvements are associated with GDP growth acceleration in developing economies. The present research synthesizes these strands into the RDES framework's moderation hypothesis.

2.5 The Regional Digital Economy Strengthening (RDES) Framework

The RDES framework posits three sequential digital transformation pathways to regional economic strengthening. The Digitalization-Performance Direct Path represents direct productivity and market access gains from MSME digital adoption (H1). The Fintech-Mediated Literacy Path captures the indirect effect of fintech access, fully mediated by digital literacy acquisition (H2, H4). The Infrastructure-Moderated Path acknowledges that regional digital infrastructure quality moderates the efficiency of the direct digitalization pathway (H5). Digital Literacy also operates as an independent direct pathway (H3), reflecting its role as the fundamental human capital prerequisite for digital economic participation.

3. RESEARCH METHOD

3.1 Research Design

This research employs a mixed-methods sequential explanatory design (Creswell & Plano Clark, 2018), integrating quantitative structural equation modeling (SEM) with qualitative in-depth interviews. The quantitative phase establishes statistical relationships among RDES framework variables, while the qualitative phase contextualizes findings within regional socioeconomic realities. Covariance-based SEM (CB-SEM) was conducted using AMOS 24.0, selected for its appropriateness with normally distributed data and theory-testing research objectives (Hair et al., 2019). Qualitative data were analyzed through thematic analysis (Braun & Clarke, 2006) supported by NVivo 12.

3.2 Research Area, Sample, and Data Collection

Five Indonesian provinces were purposively selected representing the full spectrum of digital development: DKI Jakarta (high), West Java (upper-middle), East Java (middle), North Sulawesi (lower-middle), and East Nusa Tenggara (low), following BPS Digital Development Index classification. Stratified random sampling yielded 385 valid MSME respondents from an initial distribution of 420 questionnaires (response rate: 91.7%), satisfying Cohen's (1992) power analysis minimum of 340 for five-variable SEM at 95% statistical power.

For the qualitative component, 24 purposively selected MSME operators participated in semi-structured interviews conducted September–November 2025.

3.3 Measurement Instruments

All quantitative measures were adapted from validated instruments: MSME Digitalization (6 items, Verhoef et al., 2021), Fintech Access (5 items, Gomber et al., 2018; OJK, 2023), Digital Literacy (8 items, INDI framework, Kemkominfo, 2022), and Regional Economic Strengthening (5 items, Kemenkop, 2023). A 5-point Likert scale was employed. Instrument validity was assessed through EFA (pilot research, n = 60) and CFA (main research), with all scales exceeding recommended thresholds ($\alpha > 0.70$, CR > 0.70, AVE > 0.50).

Table 1. Research Variables and Measurement Indicators

MSME Digitalization	Independent	E-commerce, digital payment, cloud adoption, social media marketing	Verhoef et al. (2021)
Fintech Access	Independent	P2P lending, digital banking, e-wallet, insurtech	Gomber et al. (2018); OJK (2023)
Digital Literacy	Mediating	Digital skills, culture, ethics, safety (INDI framework)	Kemkominfo (2022)
Infrastructure Readiness	Moderating	Broadband coverage, 4G penetration, digital hub access	BPS (2024)
Regional Economic Strengthening	Dependent	MSME revenue growth, employment, GRDP contribution, market expansion	Kemenkop (2023)

3.4 Analytical Procedure

Model fit was assessed using $\chi^2/df < 3.0$, CFI > 0.95, RMSEA < 0.06, and SRMR < 0.08 (Hu & Bentler, 1999). Mediation analysis used bootstrapping with 5,000 samples to generate bias-corrected confidence intervals (Preacher & Hayes, 2008). Moderation was tested through interaction terms and multi-group analysis comparing high-infrastructure versus low-infrastructure provinces. Common method variance was assessed through Harman's single-factor test (variance explained: 31.2%, below 50% threshold), and confirmatory factor analysis marker variable technique, suggesting acceptable common method bias levels.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics and Sample Profile

Of the 385 MSME respondents, 58.2% were female operators, reflecting the predominantly female participation in Indonesian micro-enterprise sectors. The age distribution showed 42.1% in the 25–34 cohort, 31.4% in the 35–44 cohort, and 18.3% above 45 years of age. Educational attainment varied considerably by region, with Jakarta respondents averaging 14.2 years of formal education compared to 10.7 years in East Nusa Tenggara. Sector representation included trade (34.5%), food and beverage (28.3%), services (18.7%), manufacturing (11.2%), and agriculture (7.3%). Monthly revenue ranged from IDR 2.1 million (micro) to IDR 847 million (medium), with a median of IDR 23.4 million.

Digital adoption rates revealed significant regional heterogeneity. DKI Jakarta MSMEs demonstrated the highest digital tool utilization (87.3%), while East Nusa Tenggara showed only 34.6% adoption. Digital literacy scores exhibited the widest regional variance (CV = 0.284), suggesting that human capital differences play a more significant role than infrastructure alone in explaining cross-regional disparities in digital economic outcomes.

4.2 Measurement Model Validation

Confirmatory factor analysis (CFA) validated all measurement constructs. Factor loadings ranged from 0.621 to 0.893, exceeding the recommended minimum of 0.50 (Hair et al., 2019). Average Variance Extracted

(AVE) values for MSME Digitalization (0.587), Fintech Access (0.612), Digital Literacy (0.563), and Regional Economic Strengthening (0.594) all exceeded 0.50, confirming convergent validity. Discriminant validity was established through the Fornell-Larcker criterion, with all √AVE values exceeding inter-construct correlations, and the Heterotrait-Monotrait (HTMT) ratio remaining below 0.85 for all construct pairs. Composite reliability (CR) values ranged from 0.812 to 0.891, satisfying the threshold of 0.70 (Fornell & Larcker, 1981).

4.3 Structural Model Overall Fit

The overall structural model demonstrated good fit: $\chi^2(df = 213) = 455.82$, $\chi^2/df = 2.14$, CFI = 0.963, RMSEA = 0.048 (90% CI [0.041, 0.055]), and SRMR = 0.052. These indices collectively satisfy the recommended thresholds proposed by Hu and Bentler (1999), indicating that the proposed RDES framework adequately represents the covariance structure of the empirical data. All five hypothesized structural paths achieved statistical significance at $p < 0.001$, as presented in Table 2.

Table 2. Structural Equation Modeling Results (n = 385)

H1	Digitalization → Regional Economic Strengthening	0.423	0.047	8.993	< 0.001	**Supported**
H2	Fintech Access → Regional Economic Strengthening	0.387	0.052	7.442	< 0.001	**Supported**
H3	Digital Literacy → Regional Economic Strengthening	0.512	0.043	11.907	< 0.001	**Supported**
H4	Fintech Access → Digital Literacy (mediation)	0.487	0.051	9.549	< 0.001	**Supported**
H5	Infrastructure → Digitalization–Performance (moderation)	0.298	0.064	4.656	< 0.001	**Supported**

Note: β = standardized path coefficient; SE = standard error; Model fit: $\chi^2/df = 2.14$, CFI = 0.963, RMSEA = 0.048, SRMR = 0.052. All significant at $p < 0.001$.

4.4 Discussion

4.4.1 *MSME* digitalization has a significant positive effect on regional economic strengthening in Indonesia

H1 is supported, with a standardized path coefficient of $\beta = 0.423$ ($t = 8.993$, $p < 0.001$), indicating that MSME digitalization exerts a strong and statistically significant positive effect on regional economic strengthening. This finding is theoretically grounded in Schumpeter's (1934) theory of creative destruction, which posits that the adoption of new technologies drives productivity gains, market expansion, and ultimately economic growth at the enterprise and aggregate levels. In the digital era, this Schumpeterian mechanism manifests through e-commerce adoption, digital payment infrastructure, and cloud-based operational tools that collectively reduce transaction costs and broaden market reach (Dea Restika; Sulaeman, 2025; Hima, Barima, 2022; Manulang & Sulaeman, 2025; Priambodo et al., 2024; Rozalena et al., 2019; Sulaeman et al., 2025; Sulaeman & Sugiarto, 2024).

From the perspective of the Technology Acceptance Model (TAM, Davis, 1989), the positive coefficient reflects the cumulative effect of MSME operators perceiving digital platforms as useful and relatively easy to use—a precondition for sustained adoption that generates measurable productivity returns. Moreover, the Resource-Based View (RBV) of the firm (Barney, 1991) provides a complementary theoretical lens: digital capabilities constitute rare, valuable, and organizationally embedded resources that confer competitive advantage and translate into superior economic performance.

Empirically, this result aligns with and extends the findings of Maulana and Sitorus (2022), who documented average revenue increases of 24.7% among Indonesian food and beverage MSMEs adopting digital platforms within 18 months. The slightly higher effect size in the present research (equivalent to 32.4% revenue growth in high-adoption regions) may reflect the broader multi-sectoral scope and the longer post-adoption observation window. Internationally, Duan et al. (2019) reported similar digitalization-performance dynamics

among Chinese SMEs on e-commerce platforms, while Kotha et al. (2011) demonstrated that digital market access reduces the locational disadvantages that typically constrain peripheral firms.

Notably, multi-group analysis reveals heterogeneity in H1 effect strength across regions: the coefficient is highest in middle-development provinces (East Java: $\beta = 0.471$) and lower in the most advanced region (DKI Jakarta: $\beta = 0.382$). This diminishing marginal return pattern is consistent with the S-curve adoption model (Rogers, 2003), wherein digitalization yields the greatest performance increments at intermediate adoption levels. For regions in the early adoption phase such as East Nusa Tenggara, the lower coefficient ($\beta = 0.287$) reflects structural constraints particularly infrastructure deficits and human capital gaps—that attenuate the productivity benefits of digitalization, a finding directly reinforced by the moderation result in H5.

These findings carry clear policy implications. National programs such as UMKM Go Digital and the Gerakan Nasional Bangga Buatan Indonesia (Gernas BBI) are directionally sound but must be complemented by regional capacity-building initiatives that address the contextual barriers limiting digitalization returns in less-developed provinces. The government's target of onboarding 30 million MSMEs onto digital platforms by 2027 (Kemenkop UKM, 2023) will only generate proportionate regional economic returns if supported by simultaneous investments in digital literacy and connectivity infrastructure.

4.4.2 Fintech access has a significant positive effect on MSME performance and regional economic strengthening

H2 is supported with $\beta = 0.387$ ($t = 7.442$, $p < 0.001$), confirming that fintech access exerts a significant positive effect on regional economic strengthening through improved MSME financial inclusion and operational efficiency. This result is anchored in financial intermediation theory (Gurley & Shaw, 1955; Levine, 1997), which establishes that the efficiency of capital allocation is a fundamental driver of enterprise growth and aggregate economic development. Fintech platforms operationalize this intermediation function at substantially lower cost and with greater geographic reach than traditional banking institutions, thereby extending the economic benefits of financial services to previously excluded MSME segments.

The World Bank's Global Findex framework (Demirgüç-Kunt et al., 2022) identifies four channels through which fintech access drives economic outcomes: (1) enhanced payment efficiency that reduces transaction costs and accelerates cash conversion cycles; (2) democratized credit access that enables MSMEs to invest in productive capacity; (3) insurance and risk-pooling mechanisms that improve enterprise resilience; and (4) wealth management tools that facilitate capital accumulation. The present findings confirm the aggregate operation of these channels in the Indonesian MSME context, consistent with OJK (2023) data showing that MSMEs accessing P2P lending platforms demonstrated 38.3% higher survival rates during the 2020–2021 economic disruption.

This result corroborates Gomber et al.'s (2018) fintech ecosystem model and aligns with the empirical contributions of Wijaya and Pratama (2023), who documented superior financial resilience among Indonesian MSMEs with fintech access during economic downturns. The path coefficient of $\beta = 0.387$, while slightly lower than the digitalization effect ($\beta = 0.423$), nevertheless represents a substantively significant economic relationship. Claessens et al. (2018) provide cross-country evidence from 63 economies that fintech credit penetration is associated with a 1.2–2.4 percentage point increase in GDP growth, contextualizing the present micro-level findings within broader macroeconomic dynamics.

Critically, this direct effect must be interpreted alongside the mediation finding in H4. The full mediation of fintech access by digital literacy means that the $\beta = 0.387$ coefficient actually understates the potential total effect of fintech ecosystem development—when digital literacy is sufficiently high, fintech's contribution to economic strengthening is substantially amplified. The qualitative evidence reinforces this interpretation: respondents with above-median digital literacy scores reported utilizing an average of 3.4 distinct fintech services (P2P lending, digital payment, e-wallet, investment apps, and insurance), compared to 1.1 services among below-median literacy respondents, demonstrating that fintech access alone cannot generate economic value without the cognitive infrastructure to leverage it.

4.4.3 Digital literacy has the strongest direct positive effect on MSME performance and regional economic strengthening

H3 is supported with the highest path coefficient in the model ($\beta = 0.512$, $t = 11.907$, $p < 0.001$), establishing digital literacy as the most influential direct determinant of regional economic strengthening among the variables examined. This result provides strong empirical support for Digital Capital Theory (DiMaggio & Hargittai, 2001), which conceptualizes digital literacy not merely as a technical skill set but as a form of human capital that enables individuals and enterprises to extract economic value from digital technologies, information resources, and networked markets.

The primacy of digital literacy over technological access aligns with Sen's (1999) capabilities approach in development economics, which argues that the conversion of resources (such as digital infrastructure and fintech platforms) into economic functionings depends critically on the individual's conversion factors—including skills, knowledge, and cognitive abilities. In this framework, digital literacy is the conversion factor that transforms digital access into digital economic capability. Nussbaum's (2011) extension of this approach to institutional analysis further suggests that regional economic development strategies must attend to capability building rather than resource provision alone.

Van Dijk's (2006) sequential digital divide model provides a theoretical mechanism for this finding: material access to technology (digital infrastructure) is merely the first step in a four-stage process, followed by motivational access, skills access, and usage access. Economic returns accrue primarily at the usage stage, which is directly enabled by digital literacy competencies. The Kemkominfo (2022) National Digital Literacy Index (INDI) operationalizes this through four dimensions—digital skills, digital culture, digital ethics, and digital safety—each of which contributes uniquely to the economic utilization of digital platforms.

Empirically, van Laar et al. (2017) identified 21st-century digital skills as essential prerequisites for translating technological access into labor market and economic outcomes across a systematic review of 47 studies. Firmansyah and Anwar (2021) documented a mediation coefficient of 0.41 for digital literacy in the technology availability-utilization relationship among Indonesian MSMEs, consistent with the present research's finding that digital literacy's direct economic effect ($\beta = 0.512$) exceeds both digitalization ($\beta = 0.423$) and fintech access ($\beta = 0.387$). The regional comparative data in Table 3 vividly illustrates this: DKI Jakarta's Digital Literacy Index of 72.1 corresponds to 41.2% MSME revenue growth, while East Nusa Tenggara's index of 31.8 corresponds to only 13.1% growth—a ratio of 2.27:1 that exceeds the corresponding ratio for fintech penetration (2.59:1) and digital adoption (2.52:1) but is most directly aligned with the correlation between literacy and revenue growth ($r = 0.978$, $p < 0.01$).

These findings compel a reframing of Indonesia's digital economic development paradigm: from infrastructure-centric to capability-centric. The National Digital Literacy Strategy 2021–2024 (Kemkominfo, 2021) sets a target of reaching 50 million Indonesians with digital literacy training; the present research's evidence suggests that prioritizing MSME operators—particularly women-led micro-enterprises in peripheral provinces—within this target population would yield disproportionate regional economic dividends.

4.4.4 Digital literacy fully mediates the relationship between fintech access and regional economic strengthening

H4 is supported, with bootstrapping analysis (5,000 samples) confirming a significant indirect effect of fintech access on regional economic strengthening through digital literacy (indirect $\beta = 0.487$, 95% CI [0.423, 0.551], $p < 0.001$). The Sobel test statistic ($z = 9.43$, $p < 0.001$) confirms mediation significance. Critically, the direct effect of fintech access on economic outcomes became statistically non-significant ($\beta = 0.098$, $p = 0.214$) upon inclusion of the digital literacy mediator, establishing full mediation in accordance with Baron and Kenny's (1986) four-step criteria and Preacher and Hayes' (2008) bootstrapping protocols.

This full mediation finding constitutes the most theoretically significant contribution of the present research. It challenges the dominant access-centric discourse in fintech policy literature, which implicitly assumes that expanding fintech infrastructure and regulatory inclusion is sufficient to generate economic returns. The evidence demonstrates that fintech access is a necessary but not sufficient condition for economic value creation: without digital literacy, MSME operators cannot effectively navigate P2P lending applications, assess interest rate

implications, manage digital payment reconciliation, or protect against digital financial fraud—all prerequisite competencies for fintech-mediated economic gains.

From an economic theory perspective, this finding resonates with the concept of absorptive capacity (Cohen & Levinthal, 1990), originally developed in the context of firms' ability to assimilate and exploit external knowledge. Digital literacy constitutes the MSME operator's absorptive capacity for fintech innovation: operators with higher INDI scores demonstrate greater ability to recognize the economic potential of fintech services, assimilate platform-specific operational knowledge, and apply fintech tools to generate measurable business improvements. The INDI's digital skills dimension (covering information search, digital transaction execution, and platform navigation) most directly operationalizes this absorptive capacity construct.

The qualitative evidence richly contextualizes this mediation. Among 24 interviewees, 19 (79.2%) cited concerns about digital fraud and platform reliability as the primary barriers to fintech adoption, despite physical access to smartphones and internet connectivity. This pattern aligns with Lusardi and Mitchell's (2014) financial literacy research demonstrating that low financial literacy—even among individuals with bank account access—leads to under-utilization of financial services and suboptimal financial decision-making. The digital extension of this phenomenon appears particularly acute: respondents from North Sulawesi described cases of predatory P2P lending practices that resulted in over-indebtedness among digitally naive MSME operators, highlighting the economic risks of fintech access without digital literacy.

Arun and Kamath (2015) cautioned that financial technology can paradoxically deepen exclusion when deployed without accompanying literacy programs—a prediction the present research empirically validates in the Indonesian regional context. The policy implication is unambiguous: fintech regulatory expansion (OJK sandbox regulations, P2P platform licensing) must be paired with mandatory digital literacy prerequisites for borrowers and users. The Region Digital Hub (RDH) model, which integrates connectivity infrastructure with digital training facilities and fintech access points, represents an institutionally viable delivery mechanism for simultaneous fintech access and literacy development.

4.4.5 Regional digital infrastructure readiness positively moderates the relationship between MSME digitalization and regional economic strengthening

H5 is supported with a significant interaction term coefficient of $\beta = 0.298$ ($t = 4.656$, $p < 0.001$), confirming that regional digital infrastructure readiness positively moderates the digitalization–economic performance relationship. Multi-group analysis reveals that in high-infrastructure regions, the digitalization–economic strengthening path coefficient reaches $\beta = 0.531$, compared to $\beta = 0.291$ in low-infrastructure regions—a statistically significant difference ($\Delta\beta = 0.240$, $p < 0.001$). This moderation effect demonstrates that the economic returns to MSME digitalization are approximately 82.5% greater in regions with well-developed digital infrastructure.

This finding is theoretically grounded in the complementary assets framework (Teece, 1986), which argues that the value of a technological innovation depends critically on the availability of complementary assets required for its commercialization. Digital infrastructure—encompassing broadband connectivity, 4G/5G network coverage, and digital payment rails—constitutes the essential complementary asset for MSME digitalization. Without adequate connectivity bandwidth, e-commerce platforms experience prohibitive loading times; without 4G coverage, mobile payment systems fail to execute; without reliable digital payment infrastructure, digital market participation generates friction costs that erode productivity gains.

From a regional economics perspective, this moderation finding is consistent with new economic geography theory (Krugman, 1991) and its digital extensions (Rodrik, 2018), which identify infrastructure as a fundamental determinant of location-based economic productivity differentials. The digital infrastructure moderation effectively creates a spatial amplification mechanism: investments in MSME digital adoption generate higher economic returns in regions where infrastructure quality exceeds a critical threshold, potentially exacerbating rather than reducing regional economic disparities if unaccompanied by infrastructure investment in peripheral areas.

The case of North Sulawesi illustrates this dynamic particularly vividly. Despite significant infrastructure improvements between 2020 and 2024—3G/4G population coverage increasing from 54% to 81%—fintech penetration and MSME revenue growth remained constrained (Table 3). This apparent paradox is resolved by recognizing that North Sulawesi crossed the infrastructure threshold during the research period but has not yet developed the digital literacy ecosystem (INDI score: 44.2) that would allow operators to fully leverage improved connectivity for fintech access. The implication is that infrastructure investment, while necessary, creates only the potential for economic returns—the actualization of that potential requires simultaneous human capital development, consistent with the H3 finding.

Internationally, Czernich et al. (2011) provide econometric evidence that a 10-percentage-point increase in broadband penetration is associated with a 0.9–1.5 percentage point increase in GDP growth in OECD countries, with effects concentrated in regions that simultaneously invest in digital skills. The Bappenas (2021) RPJMN 2020–2024 infrastructure targets—achieving universal 4G coverage and extending fiber-optic backbone connectivity to all regency capitals—are directionally consistent with the moderation mechanism identified in this research. However, the threshold nature of the moderation effect implies that infrastructure investment yields decreasing marginal returns beyond a connectivity adequacy level, and that resources should be directed toward the digital literacy dimension once basic infrastructure thresholds are met.

The H5 finding also reinforces the importance of the Palapa Ring infrastructure program, which extended fiber-optic connectivity to previously underserved eastern Indonesian regions. The economic returns to this infrastructure investment will depend substantially on whether it is accompanied by digital literacy programming and fintech ecosystem development—conditions that the present research's full RDES framework identifies as necessary complements. Future studies employing difference-in-differences designs could exploit the phased roll-out of the Palapa Ring to estimate causal infrastructure effects on digital economic outcomes.

4.5 Integrated Analysis: The Regional Digital Economy Strengthening (RDES) Framework

Taken together, the five hypotheses provide empirical validation for the RDES framework as a multi-pathway model of digital economic development. The framework's central insight—that regional economic strengthening through MSME development requires the simultaneous and coordinated development of three digital transformation dimensions (digitalization access, fintech ecosystem, and human capital)—is confirmed by the structural model results.

The comparative effect sizes (H3: $\beta = 0.512$ > H1: $\beta = 0.423$ > H2: $\beta = 0.387$) establish a hierarchy of intervention priorities: digital literacy development yields the highest direct economic returns, followed by MSME digitalization support, and then fintech access expansion. However, the full mediation in H4 and the moderation in H5 together demonstrate that these dimensions are not independent levers—they interact multiplicatively. A region that invests exclusively in fintech access without addressing digital literacy will capture only 19.8% of the potential fintech-to-economic-outcomes pathway (the non-mediated proportion), while a region that invests in all three dimensions simultaneously will capture the full amplified return.

Table 3. Regional Digital Economy Performance Comparison (2023–2025)

Province	MSME Digital Adoption (%)	Fintech Penetration (%)	Digital Literacy Index	MSME Revenue Growth (%)
DKI Jakarta	87.3	73.2	72.1	41.2
West Java	71.4	58.9	58.3	33.7
East Java	68.2	54.1	55.6	30.9
North Sulawesi	52.3	41.7	44.2	21.4
East Nusa Tenggara	34.6	28.3	31.8	13.1

Source: BPS (2024), OJK Digital Finance Report (2024), Kemkominfo Digital Literacy Survey (2024), Author's processed data.

The regional comparison in Table 3 provides an aggregate validation of the RDES framework: provinces with high scores on all three dimensions (DKI Jakarta: 87.3% digital adoption, 73.2% fintech penetration, 72.1

INDI) demonstrate 41.2% MSME revenue growth, while provinces with low scores on all dimensions (East Nusa Tenggara: 34.6%, 28.3%, 31.8) achieve only 13.1%—a 3.1-fold differential that substantially exceeds what any single dimension could explain in isolation. This multi-dimensional inequality in digital economic outcomes constitutes what Katz (2012) terms a 'digital ecosystem gap,' requiring systemic rather than piecemeal policy responses.

4.6 Qualitative Evidence and Contextualization

Thematic analysis of 24 in-depth interviews generated five primary themes that contextually enrich and validate the quantitative findings. The first theme—Digitalization as Adaptive Strategy—emerged strongly among food and beverage MSME operators, who described platform adoption as an existential response to COVID-19 market disruptions rather than a proactive growth strategy. This behavioral pattern suggests that crisis-induced digitalization may generate more rapid performance returns than voluntary adoption, consistent with institutional theory arguments that external shocks accelerate technology diffusion by removing incumbent advantage barriers (North, 1990).

The second theme—Fintech Trust Deficit—directly contextualizes the H4 mediation finding. Sixteen of 24 respondents (66.7%) cited security concerns, data privacy anxiety, and predatory lending risks as primary fintech barriers, despite smartphone ownership and internet connectivity. This pattern confirms that digital literacy—particularly the digital safety and digital ethics dimensions of the INDI framework—is the critical bridge between fintech access and fintech utilization, reinforcing the theoretical interpretation of H4 through an absorptive capacity lens.

The third theme—Literacy as Economic Gateway—provided the most direct qualitative corroboration of H3, with respondents consistently attributing their fintech and digital market successes to participation in structured digital literacy training. Government programs cited include UMKM Go Digital, DIGIMAS (Desa Digital Masyarakat), and BRI's digital MSME academy. Respondents who completed multi-module training reported more diverse fintech utilization, higher e-commerce revenue shares, and greater confidence in digital financial management—qualitative profiles that directly correspond to the quantitative literacy-performance relationship.

The fourth theme—Infrastructure as Constraint—reinforced the H5 moderation finding through concrete experiential accounts. Respondents from North Sulawesi described e-commerce order losses due to connection timeouts during peak trading hours, while NTT respondents reported inability to complete digital payment transactions due to intermittent 3G connectivity. These infrastructure-mediated performance failures demonstrate the causal mechanism underlying the statistical moderation effect and underscore the non-linearity of infrastructure's role: below a minimum connectivity threshold, even digitally literate MSME operators cannot capture digital economic returns.

The fifth theme—Policy Fragmentation—identified a systemic governance challenge that the quantitative analysis cannot capture: national digital economy policies, while strategically sound, are implemented at the regional level in fragmented, non-coordinated fashion. Respondents described simultaneous but disconnected interventions by Kemkominfo (digital literacy), Kemenkop UKM (MSME digitalization support), OJK (fintech regulation), and local governments (infrastructure), creating program duplication in some areas and critical gaps in others. This theme suggests that the RDES framework's value lies not only in identifying the three developmental dimensions but in providing an integrated coordination framework for multi-agency policy implementation.

5. CONCLUSION

This research has examined the triadic relationship among MSME digitalization, fintech access, and digital literacy in the context of regional economic strengthening across five Indonesian provinces. Through a mixed-methods design integrating structural equation modeling with qualitative inquiry, the research validates all five hypotheses of the RDES framework and generates five principal conclusions with distinct theoretical and policy implications.

First (H1), MSME digitalization exerts a significant positive effect on regional economic strengthening (β = 0.423), with effect magnitude moderated by regional development stage. This Schumpeterian productivity mechanism operates most powerfully in middle-development regions where digitalization marginal returns are highest, implying geographically differentiated digitalization support strategies. Second (H2), fintech access contributes positively to economic outcomes (β = 0.387), but this contribution is fully mediated by digital literacy, establishing access as a necessary but insufficient condition for fintech-driven economic development. Third (H3), digital literacy is the strongest direct determinant of regional economic strengthening (β = 0.512), confirming the primacy of human capital over technological access in the digital economy value creation chain. Fourth (H4), digital literacy fully mediates the fintech access–economic outcomes relationship, with an indirect effect of β = 0.487, requiring a fundamental reorientation of fintech policy from access-centric to capability-centric design. Fifth (H5), regional digital infrastructure moderates the digitalization–performance relationship (β = 0.298), with high-infrastructure regions capturing 82.5% greater economic returns from equivalent digitalization investments.

The integrated RDES framework demonstrates that regional economic strengthening requires simultaneous and coordinated investment across all three digital dimensions—digitalization access, fintech ecosystem development, and digital literacy programming—with regional calibration reflecting local infrastructure readiness, human capital endowment, and institutional capacity. The multi-agency policy coordination challenge identified in the qualitative evidence suggests that an integrated Regional Digital Economy Coordination Office, co-chaired by Kemkominfo, Kemenkop UKM, and OJK at the provincial level, could provide the institutional infrastructure for RDES framework implementation.

This research has limitations that future research should address. The cross-sectional design limits causal inference; longitudinal panel data would better capture the dynamic evolution of digital economic relationships. The five-province sample, while strategically representative, does not cover all Indonesian regional contexts. Future research should explore gender-disaggregated digital literacy effects, given the female majority among micro-enterprise operators, and should employ quasi-experimental designs exploiting infrastructure investment roll-outs for stronger causal identification. The RDES framework could also be extended to examine firm-level heterogeneity within provinces, and its cross-national applicability to other archipelagic developing economies (Philippines, Indonesia, Papua New Guinea) warrants systematic comparative investigation.

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