



DIGITAL MICRO-ENTREPRENEURSHIP AND LOCAL INNOVATION SYSTEMS FOR ADVANCING VILLAGE ECONOMIC GROWTH

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Abstract

This research investigates digital micro-entrepreneurship in rural areas through the local innovation systems framework. Addressing limited formal employment, seasonal agricultural income, and digital divides, this study examines how smartphone platforms create market pathways while raising concerns about uneven value capture and exclusion. The study maps the entrepreneur typology, explains how digital technologies reshape the dynamics of the innovation system, and identifies constraints that affect the quality and sustainability of entrepreneurship. Employing qualitative case study methodology, data were collected through interviews, focus groups, and system actor mapping from January to December 2024. Three villages were selected: Village A (peri-urban, strong connectivity), Village B (agricultural, moderate connectivity), and Village C (remote, unreliable). Among 45 identified micro-entrepreneurs, 60% are women aged 25-40. Findings reveal social selling ecosystems dominate, with hybrid online-offline models prevailing due to trust and payment preferences. Digitalization accelerates knowledge flows through trans-local learning and enables partial institutional evolution, most effectively in digitally-advantaged villages. However, the lack of formal financial records constrains assessment. Digital tools catalyze rural innovation system reconfiguration, but benefits remain mediated by digital literacy, capital access, and social support. Implications emphasize tiered policy formalization, cooperative digital infrastructure, and targeted financial inclusion. Study limitations include a small sample (45 entrepreneurs from 3 villages), a geographic focus on 1 district, self-reported data, and a 12-month time frame.

Keywords: *digital micro-entrepreneurship; rural innovation systems; digital inclusion; hybrid business models; village economic transformation*

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INTRODUCTION

The intersection of digital micro-entrepreneurship with local innovation systems presents a particularly promising yet underexplored frontier in rural development

scholarship and practice. Regional innovation systems—conceptualized as territorially embedded networks of actors, institutions, and relationships facilitating knowledge creation, diffusion, and application—have long been recognized as crucial determinants of regional economic dynamism, yet their operation in rural contexts characterized by resource scarcity, institutional weakness, and geographic dispersion remains inadequately understood (Sifolo & Sokhela, 2022; Zafri et al., 2025). Digital technologies offer the potential to overcome traditional limitations of rural innovation systems by enabling virtual connectivity, reducing transaction costs for knowledge exchange, and facilitating access to extra-local expertise and market intelligence to compensate for thin local networks (Thakur et al., 2023; Zafri et al., 2024). However, realizing this potential requires not simply technology deployment but careful attention to how digital tools integrate with and potentially transform existing social, institutional, and economic structures at the village level, creating new forms of innovation capacity while navigating tensions between digital disruption and local embeddedness.

Micro-entrepreneurship in rural contexts has historically served as a critical livelihood strategy for households facing limited formal employment opportunities, providing flexible income-generation opportunities that complement agricultural activities and enabling economic participation for populations—particularly women, youth, and marginalized groups—often excluded from conventional employment pathways. The digitalization of these micro-entrepreneurial activities introduces transformative potential by expanding market reach beyond local trading areas, enabling specialization in niche products and services, finding dispersed demand, and facilitating access to business support resources previously concentrated in urban centers. (Boniotti & Fossa, 2025; Estefan et al., 2024). Digital platforms for e-commerce, social media marketing, digital payments, and online learning have dramatically lowered entry barriers for rural micro-entrepreneurs while simultaneously raising complexity requirements around digital literacy, platform navigation, and online business management. (Baker, 2021; Komarraju et al., 2022). This dual dynamic of opportunity expansion and capability demands creates critical questions about inclusivity and equity in digital entrepreneurial transitions—who benefits from digitalization, who risks exclusion, and what support mechanisms enable broad-based participation rather than concentration of gains among already-advantaged actors.

The concept of local innovation systems provides an essential analytical framework for understanding how village-level economic growth emerges not from isolated entrepreneurial heroics but through systemic interactions among diverse actors, including entrepreneurs, local government, educational institutions, financial service providers, business associations, and community organizations. These systems exhibit distinct characteristics in rural contexts compared to well-studied urban and regional innovation systems, typically featuring thinner networks, weaker institutional infrastructure, greater reliance on tacit knowledge and informal learning mechanisms, and stronger embeddedness in social relationships and community norms. (Bögenhold, 2019). Digital technologies introduce new possibilities for innovation system evolution by enabling virtual bridging of spatial gaps, facilitating knowledge flows across geographic boundaries, and potentially accelerating innovation cycles through rapid information dissemination and collaborative tools. (Holzmann & Gregori, 2023; Zahra et al., 2023). However, technology-induced transformation of local innovation systems is not deterministic. However, it is mediated by existing institutional configurations, power dynamics, social capital patterns, and community capacities to appropriate and adapt

digital tools to local purposes—factors that demand careful empirical investigation to understand the conditions enabling the productive digitalization of rural innovation ecosystems.

Despite growing recognition of digital entrepreneurship's potential for rural development, significant challenges constrain its realization in village contexts across emerging and developing regions. The persistent digital divide—encompassing not only infrastructure gaps in connectivity and device access but also more fundamental disparities in digital literacy, platform familiarity, and capability to leverage digital tools for economic purposes—creates systematic exclusion risks where digitalization benefits already-connected populations while marginalizing those lacking resources, education, or social capital to navigate digital transitions. (Lamine et al., 2023; Si et al., 2023). Rural micro-entrepreneurs frequently face multiple intersecting barriers, including unreliable internet connectivity disrupting business operations, limited access to digital payment systems reducing transaction efficiency, insufficient digital skills constraining effective platform utilization, and weak business management capacity limiting the ability to translate digital market access into sustainable enterprise growth (Oppong et al., 2020; Zhang et al., 2023). These individual-level constraints interact with systemic weaknesses in rural entrepreneurial ecosystems, including a shortage of locally available business development services with digital expertise, limited financial institutions' understanding of digital business models, which constrains credit access, and policy frameworks designed for traditional enterprises that fail to address the specificities of digital entrepreneurship.

The systemic dimensions of constraints facing digital micro-entrepreneurship in rural areas extend beyond individual capacity gaps to encompass fundamental weaknesses in the functionality and governance of local innovation systems. Many village contexts lack critical innovation infrastructure, including maker spaces, business incubation facilities, digital skills training programs, and intermediary organizations facilitating knowledge exchange and collaboration among entrepreneurs, creating thin supportive ecosystems offering minimal assistance to aspiring or struggling micro-entrepreneurs (Rippa & Secundo, 2019). The absence or weakness of bridging institutions connecting local entrepreneurs with extra-local knowledge sources, market opportunities, technology providers, and policy resources constrains innovation capacity and market expansion, trapping many microenterprises in low-value, commodity-based competition rather than enabling them to move toward higher-value, differentiated offerings. (Katzer & Sendlhofer, 2023; Müller & Korsgaard, 2018). Furthermore, policy and regulatory frameworks frequently exhibit urban bias in design and implementation, failing to address rural-specific challenges such as infrastructure deficits, geographic dispersion, limited institutional capacity, and social and cultural contexts shaping entrepreneurial behavior—resulting in well-intentioned programs achieving limited rural impact despite stated inclusive development objectives.

Despite valuable contributions from the existing literature on digital entrepreneurship and rural innovation systems, a critical research gap remains in understanding how the emergence and evolution of digital micro-entrepreneurship dynamically interact with and transform local innovation system configurations in village contexts characterized by varying levels of digital infrastructure, institutional capacity, and social capital. This gap is particularly significant because: (1) most digital entrepreneurship research focuses on urban tech startups rather than rural micro-enterprises; (2) innovation systems literature has inadequately theorized the role of informal, trust-based coordination mechanisms prevalent in village contexts; and (3) the intersection of digital inclusion/exclusion

dynamics with innovation system evolution remains underexplored, particularly regarding how systemic factors mediate individual entrepreneurial outcomes and long-term sustainability.

The urgency of addressing these challenges and better understanding pathways for effective digital micro-entrepreneurship and local innovation system development in rural areas has intensified through multiple converging pressures and opportunities in the contemporary global context. The COVID-19 pandemic dramatically accelerated digital adoption across rural populations as lockdowns necessitated online alternatives for commerce, communication, and service access, creating both crisis-driven learning experiences that expanded digital capabilities and new dependencies on digital platforms that may prove problematic without adequate support infrastructure. (Hasan et al., 2023; Utete & Zhou, 2024).

Post-pandemic recovery imperatives emphasize building more resilient, diversified rural economies less vulnerable to external shocks, with digital entrepreneurship offering a potential pathway for economic diversification while enabling continued agricultural engagement and the complementary seasonal income valued by rural households. (Espinoza Lastra et al., 2021). Climate change impacts on traditional agricultural livelihoods create mounting pressures for rural economic adaptation and diversification, with digital micro-entrepreneurship representing a viable alternative or complementary income source, potentially less vulnerable to environmental variability, while maintaining rural residential patterns and community connections. (Akinbami, 2021; Akinbami et al., 2019).

The Indonesian context presents distinctive dynamics for the development of digital micro-entrepreneurship in rural areas. Indonesia's archipelagic geography creates pronounced digital infrastructure disparities between urban centers and rural villages, with approximately 60% of the rural regions experiencing unreliable internet connectivity despite national digitalization initiatives. The country's large informal economy sector, estimated at 55-60% of total employment, provides fertile ground for digital micro-entrepreneurship as households seek income diversification beyond subsistence agriculture. Indonesian villages exhibit strong social capital networks and cooperative traditions (*gotong royong*) that can facilitate collaborative digital entrepreneurship, while simultaneously facing cultural barriers to technology adoption, particularly among women and older populations. The government's Village Fund program, allocating approximately USD 1 billion annually to Indonesia's 74,000 villages since 2015, creates opportunities for digital infrastructure investments and entrepreneurship support, though implementation quality varies substantially across regions. These contextual factors shape both opportunities and constraints for the emergence of digital micro-entrepreneurship and the transformation of local innovation systems in Indonesian village settings.

Scholarly research on digital entrepreneurship has expanded dramatically over the past five years, yielding important insights into technological enablers, entrepreneurial behaviors, platform strategies, and ecosystem dynamics, while leaving critical gaps in rural-specific contexts and in interactions between local innovation systems. Existing literature emphasizes how digital technologies lower entry barriers, enable scalability without proportional resource requirements, facilitate global market access from remote locations, and create new business models based on platform-mediated, peer-produced, and networked business models (Oppong et al., 2020; Rippa & Secundo, 2019). Studies document successful cases of rural entrepreneurs leveraging e-commerce platforms, social media marketing, and digital payment systems to build viable businesses serving both

local and distant markets, while also identifying common pitfalls including platform dependency vulnerabilities, intense competition with limited differentiation, and challenges sustaining customer relationships in digital-mediated interactions (Hasan et al., 2023; Müller & Korsgaard, 2018; Ompusunggu & Berliana, 2023). However, this literature exhibits an urban bias in its empirical focus, with rural contexts underrepresented and often treated as marginal cases rather than distinctive settings with specific characteristics, constraints, and opportunities that demand dedicated analytical attention.

Research specifically examining local and regional innovation systems in rural or peripheral contexts has grown in recent years, challenging earlier assumptions that innovation capacity necessarily concentrates in dense urban agglomerations while revealing diverse pathways through which less-favored regions develop innovation capabilities. This scholarship identifies how rural innovation systems often rely on alternative knowledge bases—synthetic and symbolic rather than analytical—emphasize learning-by-doing and user-producer interaction rather than formalized R&D, and feature distinctive institutional arrangements reflecting social embeddedness and community orientation. (Hebinck et al., 2018; Lidén, 2016). Studies highlight the importance of bridging organizations connecting local actors with external knowledge and market networks, policy interventions supporting entrepreneurial ecosystem development, and strategic niche management enabling the emergence of new economic activities aligned with regional assets and capabilities. (Bramwell et al., 2019; Malecki, 2011). However, limited research examines how digital technologies specifically transform rural innovation systems, with most studies predating or engaging only minimally with the dramatic digital acceleration of recent years and its implications for knowledge flows, network formation, and innovation processes in rural contexts.

Despite valuable contributions from digital entrepreneurship scholarship and rural innovation systems research, fundamental gaps remain regarding the intersection of these domains and the specific dynamics of digital micro-entrepreneurship within evolving local innovation systems in village contexts. Existing research rarely integrates micro-level analysis of individual entrepreneur experiences, behaviors, and outcomes with meso-level examination of innovation system structures, institutions, and relationships, limiting understanding of how individual entrepreneurial actions aggregate into system-level patterns and how system characteristics enable or constrain individual possibilities. (Roundy et al., 2018). The literature provides insufficient attention to mechanisms through which digital technologies catalyze or inhibit innovation system evolution, including how digital platforms reconfigure market access and knowledge flows, how virtual connectivity complements or substitutes for physical proximity, and how platform-mediated interactions transform trust-building, learning, and collaboration processes that underpin innovation systems. (Kolloch & Dellermann, 2018). Furthermore, limited research examines distributional dimensions of digital micro-entrepreneurship and innovation system development, investigating who participates and benefits, what exclusion mechanisms operate, and how interventions can promote inclusive rather than elite-captured development trajectories.

The objective of this research is to examine the emergence and evolution of digital micro-entrepreneurship within rural village contexts, focusing on its contributions to local economic growth and innovation systems. The study aims to characterize the landscape of digital micro-entrepreneurship, analyze how local innovation systems enable or constrain entrepreneurial activities, investigate how digital technologies reshape local networks and

institutional practices, and assess the economic impacts at various levels (individual, household, village). Additionally, it explores the mechanisms of inclusion and exclusion in digital micro-entrepreneurship and identifies effective intervention strategies and policy approaches to promote sustainable, inclusive growth.

This research addresses the following specific questions: (1) What is the typology and spatial distribution of digital micro-entrepreneurs in rural village contexts, and how do their business models vary across different connectivity environments? (2) Through what mechanisms do digital technologies transform local innovation system structures, knowledge flows, and institutional arrangements? (3) What factors enable or constrain the quality, sustainability, and inclusivity of digital micro-entrepreneurship across different village contexts? (4) What are the economic impacts of digital micro-entrepreneurship at individual, household, and village levels, and how do these impacts vary across entrepreneur characteristics and village contexts?

This research provides valuable insights for academics, policymakers, and development practitioners. For academia, it extends the study of digital entrepreneurship and innovation systems into rural areas, addressing gaps in inclusion and equity. For policymakers and development practitioners, it offers evidence-based recommendations on fostering digital entrepreneurship and strengthening local innovation ecosystems, particularly in resource-constrained contexts. For rural communities and entrepreneurs, the research highlights viable digital business models, necessary capabilities, and the role of networks and institutional resources. The broader implications of this study advance sustainable rural development by showing how digital micro-entrepreneurship can strengthen local economic agency, resilience, and adaptability in the face of global challenges.

RESEARCH METHOD

This study employs a qualitative research approach, using a multiple-case study design, to investigate digital micro-entrepreneurship and local innovation systems in village contexts. The qualitative methodology is appropriate for exploring complex social phenomena, understanding lived experiences of rural entrepreneurs, and examining institutional and relational dynamics within local innovation systems that resist quantification. The research adopts a purposive sampling strategy to select three villages representing diverse rural contexts: one peri-urban village with relatively good digital infrastructure (Village A), one agricultural village with moderate connectivity (Village B), and one remote village facing significant infrastructure constraints (Village C). Within each town, participants are selected through maximum variation sampling to capture diverse entrepreneurial experiences across gender, age, education level, business type, and digital adoption stage. The target sample includes 45 digital micro-entrepreneurs (15 per village), 15 key informants from local innovation system actors (village government officials, cooperative leaders, business association representatives, educational institution staff, and financial service providers), and nine focus group discussions with community stakeholders, including women's groups, youth organizations, and traditional business operators. This sampling strategy enables both within-case depth and cross-case comparison while ensuring representation of diverse perspectives and positions within local entrepreneurial ecosystems.

Data collection involves several qualitative instruments: semi-structured interviews with entrepreneurs, key informant interviews with system actors, and focus group discussions with community stakeholders. Supplementary methods include participant

observation of entrepreneurs' practices, use of digital platforms, and document analysis of local development plans and business records. Interviews are conducted at participant-convenient locations and audio-recorded with consent, followed by transcription and translation for analysis. Data collection spans four phases: preparatory activities and village selection; primary data collection; and follow-up interviews and data analysis. Data analysis follows thematic analysis, starting with open coding to identify basic concepts and patterns, then progressing to focused coding to organize the data around research objectives. The analysis also includes cross-case comparison to identify generalizable findings and context-specific variations. To ensure analytical rigor, the study employs strategies such as investigator triangulation, data source triangulation, peer debriefing, and member checking to generate models and insights that can inform policies to support inclusive, digital entrepreneurship-driven village economic growth.

RESULT AND DISCUSSION

1. The Landscape of Digital Micro-Entrepreneurship in Village Contexts

Across all three villages, digital micro-entrepreneurs are predominantly young adults aged 25-40, with higher educational attainment than village averages, reflecting the digital literacy threshold required for effective online business operation. Women constitute approximately 60% of digital micro-entrepreneurs, significantly higher than their representation in traditional village businesses, suggesting that digital entrepreneurship offers particularly valuable opportunities for women whose mobility and access to formal employment may be constrained by social norms and family responsibilities. The typical entrepreneurial journey begins with experimentation using personal social media accounts to sell products informally to friends and extended networks, gradually professionalizing through dedicated business accounts, expanded product lines, and more systematic operations as sales grow. Most entrepreneurs are necessity-driven rather than opportunity-driven in initial motivation, seeking additional household income to supplement insufficient agricultural earnings or replace lost employment. However, many subsequently develop genuine entrepreneurial orientation and growth aspirations as their businesses succeed.

The digital tools and platforms utilized by village micro-entrepreneurs reveal a pragmatic technology adoption pattern focused on free or low-cost solutions accessible via smartphones rather than requiring computers or paid software. Facebook and Instagram dominate as marketing and customer acquisition channels, chosen for their large user bases, visual product showcase capabilities, and zero direct costs. WhatsApp serves as the universal customer relationship management system, with entrepreneurs managing order inquiries, payment confirmations, delivery coordination, and after-sales service through individual and group chats. Google Maps helps customers locate physical pickup points, while Google Translate assists entrepreneurs serving customers speaking different languages. Free photo editing apps like PicsArt and Canva mobile enable product photography enhancement and promotional graphic creation. Payment collection occurs primarily through bank transfers and digital wallets like GoPay and OVO, though cash on delivery remains essential, especially for local customers. Formal e-commerce platforms like Tokopedia and Shopee are utilized by more sophisticated entrepreneurs, particularly in Village A. Still, many find the platform fees, competition intensity, and complexity challenging, preferring direct social selling instead.

Table 1. Digital Micro-Entrepreneurship Landscape Across Three Villages

Characteristic	Village A (Peri-urban)	Village B (Agricultural)	Village C (Remote)
Number of Digital Micro-Entrepreneurs	20	17	8
Average Monthly Revenue (USD)	(400). – 1,200	200 – 600	150 – 400
Primary Business Types	Services (40%), Products (35%), Reselling (25%)	Agri-products (60%), Food processing (25%), Handicrafts (15%)	Handicrafts (50%), Specialty agri-products (38%), Services (12%)
Digital Platforms Used	Multi-platform (avg 4.2 platforms per entrepreneur)	Limited platforms (avg 2.8)	Basic platforms (avg 2.1)
Gender Distribution	Women 58%, Men 42%	Women 65%, Men 35%	Women 63%, Men 37%
Average Age	31 years	33 years	29 years
Education Level	75% secondary or higher	52% secondary or higher	38% secondary or higher
Internet Reliability Issues	15% report frequent problems	45% report frequent problems	88% report frequent problems
Primary Marketing Channel	Instagram (45%), Facebook (35%), E-commerce (20%)	WhatsApp (50%), Facebook (40%), Instagram (10%)	WhatsApp (75%), Facebook (25%)

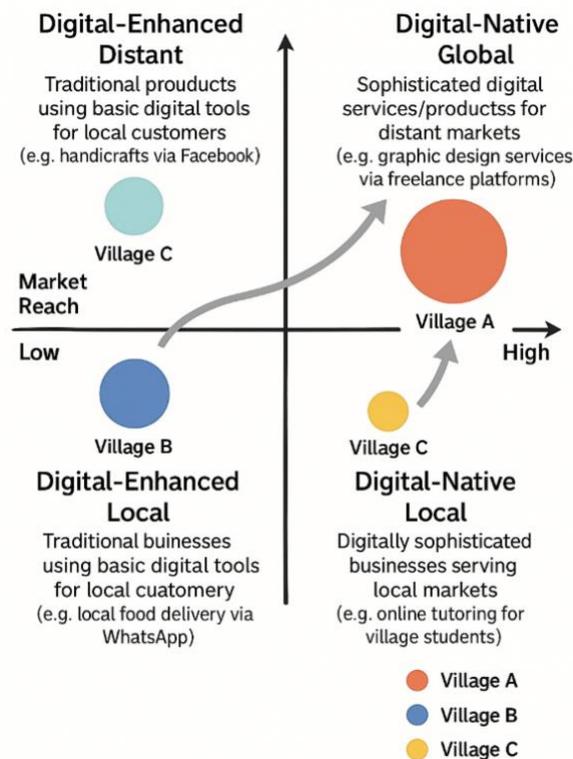


Figure 1. Digital Business Model Typology - Description for visualization

2. Local Innovation System Characteristics and Their Influence on Digital Entrepreneurship

The local innovation systems in the three study villages exhibit distinctive configurations of actors, institutions, relationships, and resources that profoundly shape the emergence and evolution of digital micro-entrepreneurship. In Village A, the local innovation system displays relatively strong institutional infrastructure, including an active village cooperative that provides business training and facilitates collective marketing, a village-owned enterprise (BUMDes) offering microfinance and business incubation space, formal connections with district-level business development agencies, and informal but active business associations organizing regular networking events.

The village government demonstrates a proactive orientation toward digital economy development, having invested in public WiFi infrastructure in the village center, organized digital literacy training programs, and designated staff to support entrepreneur registration and regulatory compliance. Local schools and vocational training centers maintain relationships with the entrepreneur community, occasionally providing student interns and graduates interested in digital business careers. Several retired urban professionals who returned to the village serve as volunteer business mentors, leveraging their external experience and networks to advise aspiring entrepreneurs. This relatively dense institutional fabric creates an enabling environment where aspiring entrepreneurs can access multiple forms of support, learn from peer experiences, and gradually build capabilities through formal and informal learning opportunities.

Village B presents a moderately developed local innovation system with functional but limited institutional capacity. The village cooperative exists and provides some services, but operates with constrained resources and aging leadership less familiar with digital business models. A BUMDes was established in response to government mandates but remains underutilized due to limited capital, unclear strategy, and insufficient staff capacity to support entrepreneurs effectively. The village government shows awareness of digital economy opportunities and expresses supportive attitudes, but lacks resources and technical knowledge to implement substantial programs beyond basic infrastructure and administrative support. Business associations are informal, with activity levels fluctuating: periodic meetings during busy seasons but minimal interaction during agricultural cycles. The primary school principal demonstrates personal interest in digital literacy and has initiated basic computer classes, but resource constraints limit the depth and reach of the programming. Agricultural extension workers visit regularly, and some have begun incorporating digital marketing topics into their farmer training programs, representing an emerging but still weak knowledge linkage. Despite these limitations, Village B's innovation system provides baseline support structures that, while insufficient to actively catalyze digital entrepreneurship, reduce barriers and offer basic resources for motivated entrepreneurs.

Village C exhibits a thin local innovation system with minimal institutional infrastructure and weak capacity to support digital entrepreneurship beyond basic administrative functions. The village lacks a functional cooperative; the BUMDes exist only on paper, with no operations or capital; and business associations are absent due to the small population and traditional economic structures. The village government, while not hostile to digital entrepreneurship, operates in survival mode, focused on basic service delivery with no bandwidth for economic development programming. No formal business training, mentoring, or incubation resources exist within the village, forcing aspiring

entrepreneurs to seek external support from district-level agencies, which require complex journeys and the navigation of unfamiliar bureaucratic processes. The limited educational infrastructure stops at primary level, with secondary education requiring boarding in distant towns, creating human capital challenges and youth out-migration patterns that deplete potential entrepreneurial talent. Despite this institutional thinness, Village C demonstrates important alternative sources of innovation system functionality through strong kinship networks and community solidarity mechanisms that provide informal business advice, peer learning, and collective problem-solving when entrepreneurs face challenges. Extended family networks in urban areas serve as critical bridges, connecting village entrepreneurs to external knowledge, market opportunities, and, at times, logistical support for product distribution.

Table 2. Local Innovation System Characteristics Across Three Villages

System Dimension	Village A (Peri-urban)	Village B (Agricultural)	Village C (Remote)
Institutional Infrastructure	Strong (cooperative, BUMDes, business association active)	Moderate (cooperative functional, BUMDes weak/inactive)	Thin (formal institutions minimal, BUMDes non-operational)
Business Support Services	Multiple sources (training, mentoring, microfinance access)	Limited (basic training available, financing minimal)	Minimal (administrative assistance only, no local financing)
Network Density	High (frequent peer-to-peer entrepreneur interaction)	Moderate (seasonal/periodic business interaction)	Low (entrepreneurs operate in isolation within village)
External Linkages	Strong (linked to district agencies, urban buyers, wider markets)	Moderate (selective district-level connections exist)	Weak (family/relative-bridged urban connections dominate)
Knowledge Infrastructure	Formal + informal learning channels active (webinars, communities of practice)	Formal knowledge limited, informal peer learning moderate	Formal learning scarce, informal learning mainly via family
Digital Infrastructure	Good (reliable internet, central public WiFi available)	Moderate (connectivity unstable at times)	Poor (frequent outages, limited bandwidth)
Institutional Formality	High (rule-based governance, formal processes clear)	Hybrid (formal mandates exist, informal execution dominant)	Low (customary and relationship-based governance prevail)
Entrepreneurial Culture	Highly supportive (innovation and growth socially valued)	Moderately supportive but traditional norms influence success display	Mostly traditional, innovation adopted cautiously
Gender Norms	Progressive (women participation broadly legitimized)	Women participation accepted with social-balance constraints	Conservative (digital access and capital for women highly constrained)

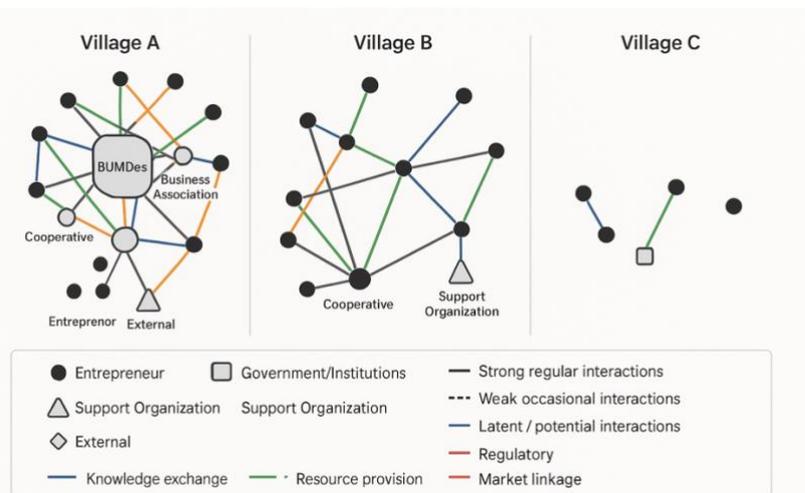


Figure 2. Innovation System Actor Network Maps - Description for visualization

3. Digital Technologies as Catalysts for Innovation System Transformation

Digital technologies have begun reshaping institutional practices and governance arrangements within local innovation systems, though these transformations remain partial and contested. Village governments increasingly use WhatsApp groups to communicate with entrepreneur communities, disseminate program announcements, collect feedback, and coordinate activities, thereby reducing transaction costs and increasing participation accessibility compared to traditional face-to-face meetings. The Village: A government created a dedicated "Village Digital Entrepreneurs" WhatsApp group that serves as a virtual business association, facilitating peer networking, enabling rapid dissemination of information on regulations and opportunities, and providing a channel for entrepreneurs to raise issues with officials without formal meeting requirements. This digital governance tool enhances administrative efficiency while potentially democratizing access for entrepreneurs who face time constraints or social anxieties about speaking in formal meetings. However, WhatsApp governance also creates new exclusionary patterns for non-digitally connected residents and risks information overload as the group accumulates messages, requiring members to filter signal from noise. Some entrepreneurs report feeling pressure to respond quickly to official messages at inconvenient times, blurring boundaries between government communication and personal life.

Cooperatives and business associations have experimented with digital tools to enhance member services and operational efficiency with mixed success across the three villages. The Village: A cooperative developed a simple mobile app that enables members to check their savings account balances, apply for loans, and register for training programs without visiting the cooperative office, reducing transaction costs and increasing service accessibility, especially for women managing time constraints. The cooperative also uses a Facebook page to market members' products collectively, creating economies of scale in digital promotion that individual entrepreneurs could not achieve on their own. These digital innovations enhanced member satisfaction and the cooperative's relevance. However, they required a significant initial investment in app development and ongoing technical maintenance, which strained the cooperative's limited budget and technical capacity. The Village B cooperative attempted similar digital initiatives but struggled with

implementation due to insufficient technical skills, limited member digital literacy, creating low adoption rates, and resistance from older leadership, who were uncomfortable with digital systems that required changes to established operating procedures. The initiative remains partially implemented, with the Facebook marketing page maintained sporadically, but the mobile app was abandoned after initial rollout difficulties.

The transformation of innovation systems through digital technologies reveals critical tensions between efficiency gains and equity concerns, between opening new opportunities and creating new vulnerabilities. Digital connectivity enables entrepreneurs to access wider knowledge networks, broader markets, and more efficient coordination mechanisms, thereby strengthening individual business performance and collective innovation capacity. However, these benefits are distributed unevenly by digital literacy, connectivity quality, and social capital, enabling effective platform navigation, creating the risk of widening inequality between digitally advantaged and disadvantaged entrepreneurs. In Village A, the strongest digital entrepreneurs increasingly operate in different competitive spaces than less digital entrepreneurs, accessing national markets and sophisticated customers. In contrast, traditional entrepreneurs remain confined to local trade, leading to diverging income trajectories and tensions within the previously more homogeneous entrepreneurial community. Village officials and cooperative leaders grapple with how to harness digital opportunities while mitigating exclusion risks, experimenting with strategies such as subsidized digital literacy training, collective marketing platforms that lower individual technical barriers, and peer mentoring programs pairing digitally sophisticated entrepreneurs with struggling entrepreneurs. These efforts show promise but remain limited in scale and sustainability, constrained by resource constraints and the rapid pace of digital change, which continually creates new capability requirements.

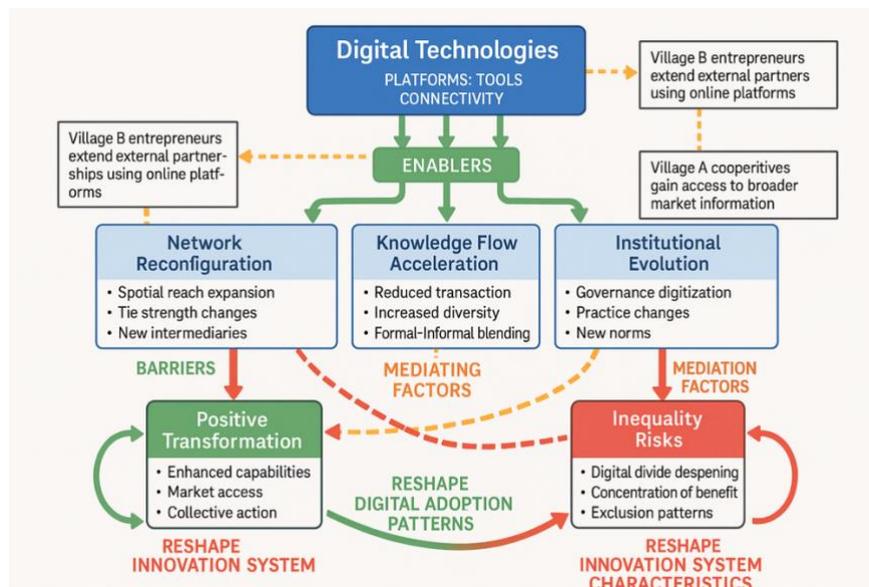


Figure 3. Digital Technology Impact on Innovation System Dynamics - Description for visualization

4. Inclusion and Exclusion Mechanisms in Digital Micro-Entrepreneurship

Digital micro-entrepreneurship in village contexts reveals complex dynamics of inclusion and exclusion, particularly along lines of gender, age, education, and access to resources. Gender plays a significant role, with digital entrepreneurship offering women flexible business opportunities that align with their domestic responsibilities, but also reinforcing gender inequalities. Women face barriers such as limited access to technology, lower confidence in technical skills, and financial constraints that hinder their business growth compared to their male counterparts. Moreover, cultural norms in certain villages restrict women's use of technology, thereby limiting their participation in entrepreneurship. Despite these challenges, digital platforms provide women with a safer space for business interactions, reducing the need for face-to-face negotiations where gendered power dynamics are more pronounced.

Age is another crucial factor in shaping participation patterns in digital entrepreneurship. Younger entrepreneurs, typically aged 25-40, are more comfortable with technology and digital tools, using them intuitively, while older entrepreneurs struggle with digital tools and display greater skepticism about digital business opportunities. This generational divide leads to a concentration of digital economic opportunities among younger populations, leaving older entrepreneurs, despite their expertise, marginalized in the digital transition. Educational attainment and digital literacy also impact inclusion, with entrepreneurs lacking basic literacy or digital skills facing substantial barriers to entering and succeeding in the digital marketplace. Formal educational credentials do not always correlate with success in digital entrepreneurship; practical experience and adaptability play a more significant role in business outcomes.

Social capital and access to economic resources further structure inclusion patterns. Entrepreneurs with strong social networks benefit from peer learning, mentoring, and access to resources, which accelerates their success. In contrast, those lacking such networks face isolation and struggle with trial-and-error learning, sometimes abandoning their entrepreneurial efforts. Women, in particular, rely heavily on family support to balance business and household responsibilities, with those receiving active family support achieving better outcomes. Economic access, including capital for investment in smartphones, the internet, and inventory, is essential for scaling businesses. Entrepreneurs with limited capital face significant challenges, including restricted access to critical tools and services, hindering their ability to grow their businesses and remain competitive in the digital economy.

Table 3. Inclusion and Exclusion Patterns in Digital Micro-Entrepreneurship

Dimension	Inclusion Factors	Exclusion Factors	Differential Impacts Across Villages
Gender	Home-based operational flexibility, lower mobility dependency, phone-based platforms	Cultural limitations on women's digital access, limited personal capital, lower technical confidence, and the competition for the unpaid domestic workload	Village A is the most inclusive for women (58% of digital entrepreneurs), and Village C exhibits the strongest gender-based constraints despite a high female share (63%)
Age	Digital-native familiarity (25-40 years), higher learning agility, openness to risk	Higher technology anxiety (50+ years), unfamiliarity with new platforms, and a	Village A has limited older participation, while Village B and C show almost no over-50

			stronger preference for traditional business customs	representation in digital entrepreneurship.
Education	Functional literacy, ability to read platform instructions, business planning, structured communication	Low foundational literacy, difficulty completing formal documentation and digital interfaces, and low platform navigation confidence		Higher-secondary-educated representation is required in Village A, while Villages B and C still enable participation at lower education thresholds but with limited sophistication.
Digital Literacy	Proficiency in smartphone use, app updates, understanding platform features/algorithms, and online negotiation without physical cues	Low security awareness, difficulty evaluating digital information, frustration with information overload, and low troubleshooting ability		Village A requires advanced digital knowledge, Village B moderate use, and Village C relies on the most basic social-selling literacy, but limits scalability.
Social Capital	Supportive ecosystem mentorship, peer learning, strong family support, and digital business referrals	Lack of reciprocal networks, social isolation in early entrepreneurial stages, weak support density, and absence of household accommodation		Dense networks in Village A accelerate capability building, while Village C heavily depends on family-bridged external support and is most sensitive to goodwill depletion.
Economic Resources	Lower physical inventory needs than traditional businesses; can operate bootstrapped via free apps.	Deep poverty constraints, lack of assets or borrowing capacity, inability to bulk-purchase materials, and no accident-buffer capital		Village A has the most credit/capital access and the highest revenue variance; Village C has the lowest capital need but the most constrained access, driving necessity-only growth.

5. Economic Impacts and Pathways to Village Economic Growth

Digital micro-entrepreneurship generates significant economic impacts at individual, household, and village levels, with income generation ranging from modest supplementary earnings to more substantial primary livelihoods. Incomes for digital entrepreneurs range from USD 30-80 for part-time operations to USD 300-800 for full-time businesses, offering greater stability than seasonal agricultural incomes. Digital businesses enable women, in particular, to generate income from home, providing both material benefits and psychological empowerment, and thereby improving their negotiating power within households. Entrepreneurs highlight income stability as more valuable than absolute income amounts, offering predictable earnings that support better financial planning and reduce vulnerability to income shocks.

The employment-creation effects of digital micro-entrepreneurship extend to family labor and occasional hired help, though most businesses remain small-scale, typically employing family members. In Village A, around 35% of entrepreneurs occasionally hired non-family workers, generating modest additional jobs. Family employment, particularly for youth, is more prevalent, with adolescents taking on roles such as order processing or

social media management. Digital entrepreneurship also diversifies village economies by creating non-agricultural income opportunities, reducing dependence on farming, and offering greater resilience to agricultural risks. Young entrepreneurs, in particular, see digital business as a way to remain in the village while earning a decent income, providing an alternative to urban migration.

However, the economic impacts of digital entrepreneurship are unevenly distributed, with considerable variation in business performance and income generation among participants. In Village A, top-performing entrepreneurs earn significantly more than lower-performing ones, often operating service-based or differentiated businesses, while those with less capital and digital expertise struggle in highly competitive markets. The sustainability of these businesses is also a concern, as many digital microenterprises face high failure rates in the first year due to factors such as unprofitability, market competition, and personal constraints. Despite these challenges, digital entrepreneurship offers valuable benefits, including income during difficult periods, skill development, and opportunities for experimentation that inform future livelihood decisions. The broader village-level economic growth driven by digital entrepreneurship depends on factors such as knowledge spillovers, infrastructure complementarity, and institutional evolution spurred by entrepreneurial activity, thereby enhancing the village's overall economic capacity.

Table 4. Economic Impacts of Digital Micro-Entrepreneurship Across Three Villages

Impact Dimension	Village A (Peri-urban)	Village B (Agricultural)	Village C (Remote)
Average Monthly Net Income (USD)	(400). – 800 (full-time), 150 – 300 (part-time)	200 – 400 (full-time), 80 – 150 (part-time)	150 – 300 (full-time), 50 – 100 (part-time)
Employment Creation	0.5 jobs per business (including family labor involvement)	0.3 jobs per business	0.2 jobs per business
Business Survival Rate (12 months)	70%	55%	50%
Income Contribution to Household	40 – 60% (full-time), 15 – 25% (part-time)	30 – 45% (full-time), 10 – 20% (part-time)	25 – 40% (full-time), 8 – 15% (part-time)
Local Input Sourcing (% of costs)	35 – 40%	50 – 60%	40 – 50%
Economic Multiplier Effect	Moderate (diverse local linkages and supply chain interaction)	Moderate (strong agricultural ecosystem linkage)	Limited (local supply chains relatively weak)
Income Inequality Impact	Widening (top performers earn 5× to 8× more than lowest tier)	Moderate (top performers earn 3× to 5× more)	Moderate (top performers earn 3× to 4× more)
Youth Retention Impact	High (digital business reduces migration dependency)	Moderate (retains some young entrepreneurs)	Low (digital opportunity cadence is limited overall)
Household Resilience Enhancement	Strong (income diversification significantly reduces economic risk)	Moderate (digital income complements agriculture)	Moderate (digital income fills the agricultural off-season)

Discussion

The findings of this research resonate with and extend several streams of existing literature while revealing significant divergences and context-specific patterns that challenge some prevailing assumptions about digital entrepreneurship and innovation systems. The documented diversity of digital business models and the creative adaptation of digital tools to local contexts align with observations that digital entrepreneurship is not monolithic but encompasses varied activities, motivations, and strategies shaped by entrepreneurs' resources, capabilities, and environmental conditions. The prominence of hybrid online-offline business models observed across all three villages echoes findings that rural entrepreneurs rarely adopt purely digital approaches, instead blending digital and traditional channels in pragmatic combinations to optimize for their specific market conditions, infrastructure constraints, and customer preferences. This pattern contradicts technology-deterministic narratives that suggest the inevitable digital displacement of physical commerce, instead revealing how digitalization reconfigures rather than eliminates place-based relationships and local embeddedness in rural entrepreneurship.

The research findings on the critical importance of digital infrastructure quality and accessibility strongly support recent scholarship that emphasizes dimensions of the digital divide beyond simple binary categories of connected/unconnected. The observed differences in entrepreneurial sophistication and business outcomes across the three villages with varying connectivity quality empirically demonstrate that infrastructure gaps constrain not only the quantity of entrepreneurship but also fundamentally shape its quality and growth trajectories. This finding validates arguments that policy attention must shift from basic connectivity provision alone toward ensuring reliable, affordable, high-quality internet access that enables meaningful economic participation rather than token digital inclusion. The research extends existing literature by documenting specific mechanisms through which connectivity constraints operate—limiting platform choices, constraining communication responsiveness, preventing the utilization of video content, and creating customer service challenges—providing a granular understanding of how infrastructure mediates between digital entrepreneurship potential and actual outcomes.

The documented gendered patterns of participation in digital entrepreneurship align with the growing recognition that digital technologies create both opportunities and constraints for women's economic empowerment, with outcomes dependent on how digital tools intersect with existing gender norms, household power dynamics, and structural inequalities. The finding that women constitute 60% of digital micro-entrepreneurs across the study villages supports observations that digital platforms offer particular advantages for women whose mobility or access to formal employment is constrained, enabling income generation compatible with domestic responsibilities. However, the research reveals more complex gendered dynamics than celebratory narratives about digital entrepreneurship as a panacea for women's empowerment would suggest. The documented barriers women face—family restrictions on digital access, capital constraints, confidence gaps, and persistent responsibility for unpaid care work limiting business time—underscore how digital opportunities remain shaped by pre-existing gender inequalities that technology alone does not eliminate and may sometimes reinforce. These findings contribute to a nuanced understanding, recognizing both genuine opportunities and persistent constraints in women's digital entrepreneurship, cautioning against technology solutionism while identifying specific mechanisms through which

digital tools can support women's economic agency when combined with attention to structural gender barriers.

The research findings on local innovation systems in rural contexts extend and complicate the existing regional innovation system literature, which has primarily focused on urban and industrialized regions. The observed importance of informal networks, tacit knowledge flows, and relationship-based coordination in village innovation systems validates theoretical arguments that rural and peripheral regions rely on alternative innovation modes that differ from the formalized, science-based innovation systems dominant in core regions. The research documents specific informal mechanisms through which knowledge circulates and entrepreneurial support occurs in resource-constrained environments—family networks connecting rural entrepreneurs with urban resources, peer learning through social rather than business relationships, and community solidarity mechanisms providing informal business support. These findings challenge deficit models that view rural innovation systems solely through their lacks relative to urban counterparts, instead revealing distinctive assets and capabilities that enable innovation despite institutional thinness and resource constraints.

However, the research also reveals important limitations and vulnerabilities of informal, relationship-based innovation systems that existing literature has sometimes romanticized in reaction to urban-centric biases. The documented challenges around knowledge access beyond immediate networks, difficulties scaling businesses beyond the capacity of personal relationships, and exclusion mechanisms that make informal systems inaccessible to those lacking appropriate social positions demonstrate the real limitations of informality that should not be minimized. The finding that innovation system formalization and institutional development in Village A enable more sophisticated entrepreneurship and better outcomes for broader populations suggests that appropriate formalization can enhance rather than undermine rural innovation capacity, contradicting perspectives that romanticize informality as inherently superior to institutional development. These findings contribute to a more balanced understanding, recognizing both the value of informal innovation mechanisms in resource-constrained contexts and the importance of formal institutional development as complements rather than either-or alternatives.

The research documents patterns of inequality emergence within digital entrepreneurship that complicate optimistic narratives about digital technologies as great equalizers and as democratizers of entrepreneurship. The finding that economic impacts concentrate among already-advantaged entrepreneurs with better education, capital access, and social connections, while marginalized entrepreneurs struggle in low-margin, competitive niches, reveals how digital opportunities can reinforce rather than reduce pre-existing inequalities. This pattern aligns with critical scholarship on digital inequalities, arguing that access to technology alone is insufficient for equitable participation when underlying capability and resource disparities remain unaddressed. The specific mechanisms through which inequality reproduces in digital entrepreneurship—differential digital literacy, unequal social capital enabling knowledge access and peer learning, capital constraints limiting business investment, and cumulative advantage dynamics where early resource positions shape ultimate success probabilities—provide granular empirical grounding for theoretical arguments about structural inequality persistence despite technological change.

The documented business failure and exit rates, with 30-50% of digital micro-enterprises ceasing or scaling back within twelve months, align with entrepreneurship

research documenting high failure rates for new ventures generally, while raising questions about digital entrepreneurship sustainability specifically in rural contexts. Previous research on digital entrepreneurship has tended to focus on successful cases while neglecting failures, potentially leading to survivorship bias and overly optimistic assessments of its viability. This research's documentation of common failure patterns—unprofitability as costs and time investments exceed revenues, intensifying market competition, platform policy changes undermining business models, and personal circumstances precluding continued business focus—provides a more realistic understanding of challenges and risks alongside opportunities. These findings suggest the need to temper the enthusiastic promotion of digital entrepreneurship with honest acknowledgment of difficulties and with the provision of support that addresses common failure causes rather than simply encouraging entrepreneurial entry without adequate preparation or support infrastructure.

The research findings on digital technologies catalyzing innovation system transformation through network reconfiguration, knowledge flow acceleration, and institutional evolution provide empirical grounding for theoretical arguments about technology-enabled systemic change while revealing important contingencies and mediating factors. The documented examples of WhatsApp groups creating virtual business associations, online learning resources supplementing thin local knowledge infrastructure, and digital platforms disintermediating traditional market relationships demonstrate concrete mechanisms through which digitalization reshapes the structures and functions of the innovation system. However, the research also reveals that technological transformation remains highly uneven and mediated by existing institutional configurations, power dynamics, and the capacity to appropriate and adapt digital tools productively. The contrast between Village A, where digital tools substantially enhanced the functionality of the innovation system, and Village C, where technology adoption remained minimal and innovation system transformation was limited, demonstrates that digital technologies are not silver bullets that automatically catalyze systemic change but rather malleable tools whose impacts depend critically on context and implementation.

The findings offer actionable insights for various stakeholders involved in digital micro-entrepreneurship. For village governments and local leaders, the research highlights the need for proactive digital economy strategies, including investing in digital infrastructure, creating business support services, and fostering entrepreneurial networks. The contrast in outcomes between villages with active support (Village A) and those with passive approaches (Villages B and C) underscores the importance of targeted interventions. For cooperatives, the research suggests the potential to develop collective digital services, such as marketing platforms and training programs, to assist digital entrepreneurs. For financial institutions, the study highlights the need for customized financial products tailored to the cash flow patterns and digital assets of digital micro-enterprises. Policymakers are urged to create supportive regulatory frameworks, incentivize infrastructure improvements, and ensure inclusive policies that support digital entrepreneurship in rural areas.

Specifically, policymakers should: (1) Establish tiered digital literacy programs with age-appropriate and gender-sensitive curricula targeting women entrepreneurs and older populations; (2) Create village-level digital hubs providing shared infrastructure (WiFi, devices, technical support) managed through existing cooperative structures; (3) Develop

micro-credit products tailored to digital business cash flows with social collateral mechanisms recognizing platform sales history; (4) Implement simplified business registration processes for digital micro-enterprises with revenue below IDR 500 million annually; (5) Pilot cooperative digital platforms enabling collective marketing, inventory management, and knowledge sharing while preserving individual entrepreneur autonomy; and (6) Establish village innovation funds allocating 10-15% of Village Fund budgets for digital entrepreneurship support with transparent selection criteria prioritizing marginalized groups.

Despite valuable insights, the study has limitations that constrain its scope. The small sample size of 23 participants and the focus on one geographic area (Kuningan district) limit the generalizability of the findings, particularly for digital micro-entrepreneurship across diverse Indonesian contexts. The short 12-month research period restricts the ability to track long-term impacts or the evolution of entrepreneurship practices. Additionally, reliance on self-reported data from entrepreneurs introduces potential biases, such as social desirability and recall bias. Future research should involve larger, multi-site studies with quantitative methods to validate findings and track long-term entrepreneurial trajectories. Furthermore, the study's focus on entrepreneurs' perspectives excluded the views of other stakeholders, such as consumers or traditional businesses, whose insights could illuminate broader social and cultural implications of digital entrepreneurship.

CONCLUSION

Based on the analysis, this study concludes that digital micro-entrepreneurship is emerging as a meaningful rural livelihood strategy that diversifies household income, expands market reach, and activates informal innovation networks, particularly among women and young adults. The presence of 45 digital entrepreneurs across the three villages demonstrates that digital tools—especially social selling via WhatsApp, Instagram, Facebook, and increasingly TikTok—are catalysts that reshape rural value chains by enabling hybrid online-offline business models, reducing intermediary dependence, and improving income stability compared to seasonal agriculture and sporadic wage labor. However, benefits remain uneven, strongly mediated by the quality of digital infrastructure, literacy thresholds, capital ownership, and the density of support networks. Village A exhibits the most enabling ecosystem, while Village C highlights resilience-driven entrepreneurship relying heavily on family-bridged external knowledge.

The study also verifies that digitalization alone does not guarantee sustainable or equitable economic transformation, as digital divides and resource asymmetries continue to influence the depth of participation and long-term business viability. For future research, a longitudinal multi-village or multi-country study over 5–10 years is recommended to track sustainability patterns, integrate non-participant perspectives (local traders, consumers, and community groups), and quantify economic impacts using objective financial data. Further studies should also explore technological upgrading interventions (e.g., cooperative digital platforms, IoT marketplace integration, and women-focused micro-credit models) and evaluate their effectiveness using mixed-

methods approaches that combine rural socio-cultural constraints with measurable development outcomes.

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