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Building Community-Based Digital Resilience through Participatory Data Literacy and Local Economic Mapping for Vulnerable Micro-Entrepreneurs

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Abstract

Vulnerable micro-entrepreneurs increasingly operate within digitally mediated markets while facing persistent limitations in data literacy, access to reliable information, digital infrastructure, and the capacity to translate local economic knowledge into adaptive business decisions. This study aimed to strengthen community-based digital resilience by integrating participatory data literacy with local economic mapping as an applied capacity-building intervention for micro-entrepreneurs. The study employed a community-based participatory approach combining baseline assessment, practical data-literacy training, participatory identification and mapping of local economic resources, mentoring, and post-intervention assessment. The intervention engaged participants in interpreting basic business and market information, identifying geographically relevant economic opportunities and constraints, and applying locally generated data to routine entrepreneurial decision-making. The results indicate that the integrated approach strengthened participants' practical engagement with digital information, improved their ability to identify and interpret business-relevant data, and increased awareness of local economic resources, market relationships, and vulnerabilities. The findings further suggest that digital resilience is strengthened when technological capabilities are connected to participatory learning and community-level knowledge rather than delivered as stand-alone digital skills. The study contributes an applied framework for linking data literacy, participatory mapping, and micro-enterprise empowerment within local economic development initiatives.

Keywords: *Community Development, Data Literacy, Digital Resilience, Micro-Entrepreneurs, Participatory Mapping*

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INTRODUCTION

The accelerating diffusion of digital technologies has altered the conditions under which micro-entrepreneurs access markets, organize business information, respond to economic shocks, and sustain livelihoods, yet the benefits of digitalization remain unevenly distributed across communities with differences in infrastructure, skills, institutional support, and socioeconomic resources. Recent scholarship increasingly frames digital transformation not merely as technology adoption but as a multidimensional process involving organizational readiness, human capabilities, adaptive practices, and the capacity to maintain economic activity under conditions of disruption (Anatan & Nur, 2023; Guandalini, 2022; Ozturk et al., 2024). Within vulnerable micro-enterprise environments, these challenges are particularly consequential because limited financial and human resources constrain the ability of business owners to independently acquire, interpret, and strategically use digital information, creating forms of digital exclusion that extend beyond simple differences in internet access (Girollet, 2024; Marshall, 2024). The emerging concept of digital resilience therefore requires attention to the community-level capabilities through which economically vulnerable actors can collectively acquire knowledge, interpret local conditions, mobilize resources, and adapt business practices rather than treating resilience as an exclusively firm-level technological capacity (Kumar et al., 2023; Tim & Leidner, 2023).

Existing empirical evidence indicates that digital capabilities can contribute substantially to the economic viability and sustainability of small enterprises, particularly when digital tools are integrated

into broader business processes rather than adopted as isolated technologies. Research on SMEs associates digital transformation with improved sustainability outcomes, while studies of e-commerce and digital marketing demonstrate that digital market participation can strengthen financial and operational performance under changing economic conditions (Gao et al., 2023; Miranda et al., 2024; Philbin et al., 2022). The literature also suggests that digital literacy constitutes an important micro-foundation of transformation because entrepreneurs must possess the ability to understand, evaluate, and apply digital information before technological resources can generate meaningful organizational value (Coco et al., 2024; Zahoor et al., 2023). Such evidence shifts the analytical emphasis from whether vulnerable entrepreneurs have access to digital technologies toward whether they possess the practical knowledge and collective support required to convert digital access into adaptive economic capabilities.

A parallel body of research demonstrates that data literacy is increasingly important for enabling individuals and organizations to interpret information, evaluate evidence, and make decisions in environments characterized by growing volumes of digital data. Data literacy education has been conceptualized as a multidimensional capability involving the interpretation, evaluation, communication, and application of data rather than the purely technical manipulation of datasets (Ghodoosi et al., 2023). For micro-entrepreneurs, this capability can influence how business owners identify customer patterns, understand market opportunities, recognize changes in local demand, compare competitors, and assess the consequences of strategic decisions, particularly when formal market intelligence systems are inaccessible or unaffordable. Yet much of the existing discussion of SME digitalization emphasizes technological adoption and organizational readiness, leaving comparatively limited attention to the ways in which community-based data literacy can be developed collectively among economically vulnerable entrepreneurs (Anatan & Nur, 2023; Zahoor et al., 2023).

The limitation becomes more pronounced when digital resilience is considered in relation to the spatial and socioeconomic characteristics of local economies, because business decisions are embedded within particular networks of suppliers, customers, infrastructure, institutions, skills, and locally concentrated economic opportunities. Participatory mapping research demonstrates that locally generated spatial knowledge can reveal contextual information that conventional datasets may overlook, while digital participatory approaches can connect community knowledge with systematic spatial analysis (Denwood et al., 2022; Denwood et al., 2023; Nurminen et al., 2024). However, participatory mapping is not inherently empowering, since the quality and relevance of its outcomes depend upon meaningful participation, appropriate methodological design, and the extent to which community members can influence the production and interpretation of knowledge (Laituri et al., 2023). The methodological challenge is therefore not simply to produce a geographic representation of local businesses but to develop a participatory process through which vulnerable entrepreneurs can identify their own economic assets, constraints, market relationships, and spatially differentiated opportunities.

The empirical literature also reveals an important conceptual separation between digital capacity-building interventions and local economic mapping initiatives, despite their potential complementarity for community development. Digital literacy and transformation studies predominantly examine individual, organizational, or technological determinants of digital adoption, whereas participatory mapping research has more often focused on spatial planning, environmental management, urban governance, or community knowledge production rather than entrepreneurial resilience (Coco et al., 2024; Brisudova et al., 2024; Pitidis et al., 2024). This separation leaves insufficiently explored the possibility that data literacy and participatory economic mapping can operate together as community capabilities through which micro-entrepreneurs understand both digital information and the territorial structures of their local economy. The gap is particularly relevant in vulnerable communities, where standardized digital training may have limited effectiveness if it is disconnected from participants' existing knowledge, livelihood strategies, social networks, and concrete economic geography.

The urgency of addressing this gap is reinforced by evidence that digital inequality persists even when basic connectivity becomes more widespread, because differences in skills, confidence, organizational capacity, and meaningful use can continue to reproduce economic disadvantages (Girollet, 2024; Marshall, 2024; Valentín-Sívico et al., 2023). Community-oriented interventions consequently need to move beyond technology dissemination toward processes that strengthen collective learning, locally relevant information practices, and the ability of residents to translate knowledge into practical economic decisions. Participatory approaches are particularly pertinent because they can position community members not merely as recipients of external expertise but as

contributors to the identification, interpretation, and validation of local problems and resources, although such participation must be structured carefully to avoid tokenistic involvement (Laituri et al., 2023; Pitidis et al., 2024). For community development practice, the central issue is therefore how to construct a capacity-building mechanism that links digital competence with locally grounded economic knowledge while simultaneously strengthening resilience among entrepreneurs who possess limited institutional and financial resources.

This study positions community-based digital resilience as an emerging intersection between digital capability development, participatory knowledge production, and community-based economic development, thereby extending conventional approaches that treat resilience primarily as an internal organizational attribute. The intervention integrates participatory data literacy with local economic mapping so that vulnerable micro-entrepreneurs can collectively identify business resources, characterize local economic relationships, interpret relevant information, and develop more informed responses to market and environmental changes. Rather than measuring digital readiness solely through ownership or frequency of technology use, the approach emphasizes practical capabilities involving information interpretation, collaborative learning, spatial awareness, decision-making, and the mobilization of community resources, consistent with broader evidence that successful digital transformation depends on organizational and human capabilities as well as technological infrastructure (Kumar et al., 2023; Su et al., 2023). The positioning also responds to evidence that digitalization can support sustainable development when technological change is connected to broader economic, social, and environmental processes rather than pursued as an isolated modernization agenda (Avelar et al., 2024; Miranda et al., 2024).

Against this background, the present study aims to develop and examine a community-based capacity-building approach that strengthens digital resilience among vulnerable micro-entrepreneurs through participatory data literacy and local economic mapping. The study contributes theoretically by conceptualizing digital resilience as a community capability produced through the interaction of individual digital competencies, shared knowledge, participatory institutions, and locally embedded economic information rather than as a purely technological or firm-level outcome. Methodologically, it contributes an integrated participatory framework that connects data literacy development with the systematic identification and visualization of local economic resources, relationships, constraints, and opportunities, creating an evidence base that can be interpreted and used by community members themselves. Practically, the study seeks to demonstrate how locally grounded knowledge production can support more inclusive community empowerment, strengthen the adaptive capacity of vulnerable entrepreneurs, and provide community stakeholders with an actionable basis for designing future interventions in digital inclusion and local economic development.

METHODS

This community-based research employed a participatory action-oriented approach to strengthen digital resilience among vulnerable micro-entrepreneurs through the integration of data literacy and local economic mapping. The intervention was implemented through four sequential stages: initial assessment, participatory capacity building, collaborative mapping, and mentoring–evaluation. The initial assessment identified participants' digital practices, access to digital tools, ability to interpret basic business information, major operational constraints, and exposure to market and digital risks through structured questionnaires, semi-structured discussions, and direct observation. The capacity-building stage subsequently delivered practical sessions on data literacy, including collecting, organizing, interpreting, and using simple business data for decision-making, while participatory mapping sessions enabled participants to identify business locations, product characteristics, suppliers, customer concentrations, market opportunities, infrastructure constraints, and other locally relevant economic resources. The participatory design followed the principle that local entrepreneurs should not merely serve as recipients of intervention but should actively contribute to defining problems, generating information, validating findings, and determining feasible business responses, consistent with the methodological concerns and opportunities identified in participatory mapping research (Denwood et al., 2022; Laituri et al., 2023; Ariyanto, 2023).

The intervention was evaluated using a mixed descriptive and participatory evaluation framework that compared conditions before and after the program across digital literacy, data-use capability, local economic awareness, and digital resilience practices. Quantitative information was collected through

pre- and post-intervention questionnaires using structured indicators covering digital tool utilization, data-management practices, interpretation of basic business information, online risk awareness, digital market access, and the ability to use locally generated economic information in business planning; changes were summarized through frequency distributions, percentage differences, and normalized improvement measures. Qualitative evidence was obtained from mentoring records, participant reflections, field observations, mapping outputs, and group discussions, allowing quantitative changes to be interpreted within the practical context of participants' businesses. The analytical framework treated digital resilience as more than technology adoption, emphasizing the capacity to anticipate, absorb, adapt to, and respond to disruptions through appropriate use of digital resources and information (Tim & Leidner, 2023; Kumar et al., 2023), while the integration of data literacy and participatory economic mapping was intended to connect individual entrepreneurial capabilities with community-level knowledge and locally grounded decision-making. This design also recognizes that digital transformation among micro-enterprises is shaped by organizational readiness, digital capability, contextual barriers, and managerial attributes rather than technology access alone (Anatan & Nur, 2023; Coco et al., 2024; Zahoor et al., 2023; Rupeika-Apoga & Petrovska, 2022).

RESULTS AND DISCUSSION

Baseline Digital Capability and Community Economic Vulnerability

The initial assessment established that digital resilience among vulnerable micro-entrepreneurs should be understood as a multidimensional capability rather than as a simple measure of whether participants owned smartphones or had access to internet connectivity. The assessment framework examined five interconnected dimensions: access to digital devices and connectivity, practical digital literacy, ability to collect and interpret business information, use of digital channels for economic activity, and capacity to respond to disruptions through digital resources. This multidimensional framing is consistent with evidence that digital transformation among SMEs depends on organizational readiness and human capabilities rather than technology availability alone (Anatan & Nur, 2023; Zahoor et al., 2023). It also responds to the observation that digital divides increasingly concern differences in meaningful use, skills, confidence, and economic benefits rather than connectivity alone (Girollet, 2024; Marshall, 2024).

Table 1. Baseline assessment framework for participating micro-entrepreneurs

Dimension	Baseline indicator	Measurement approach	Evidence collected
Digital access	Smartphone/device and internet access	Structured questionnaire	Participant responses
Digital literacy	Ability to perform essential digital tasks	Practical assessment	Task completion
Data literacy	Ability to collect, organize and interpret business data	Case-based exercise	Participant worksheets
Digital business use	Use of digital channels for business activities	Questionnaire and observation	Business profiles/channels
Digital resilience	Ability to respond to business disruption using digital resources	Scenario-based assessment	Participant responses
Local economic awareness	Knowledge of suppliers, customers, competitors and local opportunities	Participatory discussion	Mapping records

The baseline assessment further emphasized that digital vulnerability cannot be reduced to a lack of technical knowledge, because entrepreneurs may possess devices and internet access while still lacking the capacity to convert digital resources into commercially useful information. This distinction is important because digital transformation requires entrepreneurs to connect technological resources with managerial judgment, market knowledge, and organizational routines (Coco et al., 2024; Malodia et al., 2023). The assessment therefore focused on what participants could actually do with information rather than what technologies they possessed. Such an approach is also compatible with the

conceptualization of digital resilience as the ability of organizations and individuals to anticipate, absorb, adapt to, and recover from digitally mediated disruptions (Kumar et al., 2023; Tim & Leidner, 2023).

A second baseline concern involved the limited integration of business information into routine decision-making. Micro-entrepreneurs frequently operate through experiential knowledge, interpersonal relationships, and accumulated familiarity with customers, yet these forms of tacit knowledge are not always translated into structured records that can be compared across periods or used to identify emerging patterns. Data literacy training therefore needs to address not only technical procedures but also the ability to formulate useful questions, distinguish relevant from irrelevant information, and interpret simple evidence in relation to business decisions (Ghodoosi et al., 2023). This orientation is particularly relevant for vulnerable enterprises because sophisticated analytical systems are often inaccessible, whereas basic structured information can already support improvements in customer identification, product planning, pricing, and market monitoring.

Table 2. Baseline dimensions of community economic vulnerability

Vulnerability dimension	Local manifestation to be documented	Potential consequence	Intervention response
Market vulnerability	Dependence on a narrow customer base	Demand instability	Market mapping
Information vulnerability	Limited structured business records	Weak decision-making	Data literacy
Digital vulnerability	Limited productive use of digital platforms	Restricted market reach	Practical digital training
Spatial vulnerability	Limited knowledge of nearby economic resources	Missed local opportunities	Economic mapping
Network vulnerability	Weak connections with suppliers/partners	Higher transaction constraints	Community networking
Shock vulnerability	Limited contingency strategies	Slow business adaptation	Digital resilience exercises

The findings framework also treated local economic vulnerability as spatially embedded. Entrepreneurs do not operate in an abstract market; their activities are connected to particular customer concentrations, supplier locations, transportation routes, community institutions, competing enterprises, and digital access points. Participatory mapping provides a mechanism for bringing these relationships into a shared analytical space, allowing local actors to identify resources and constraints that may not be visible through conventional statistical datasets (Denwood et al., 2022; Ariyanto, 2023). This is particularly important in community-based interventions because the objective is not simply to produce a map but to transform dispersed local knowledge into a resource for collective decision-making.

The participatory assessment also revealed the methodological importance of allowing participants to validate the information represented in the mapping process. Spatial information collected remotely or retrospectively may differ from information generated through direct community experience, making validation essential when maps are intended to guide local interventions (Brisudova et al., 2024). The mapping process therefore incorporated participant discussion and verification rather than treating externally available spatial information as automatically authoritative. This approach is consistent with critical scholarship emphasizing that participation must involve substantive influence over knowledge production rather than merely providing information to researchers (Laituri et al., 2023).

The baseline stage consequently functioned as more than a diagnostic exercise; it became the first mechanism through which participants recognized relationships between their individual business challenges and broader community-level conditions. Participants could identify how customer accessibility, local infrastructure, supplier networks, neighboring businesses, and digital visibility interacted with their entrepreneurial opportunities. Such collective interpretation is consistent with

participatory mapping approaches that use spatial knowledge to strengthen community understanding and planning capacity (Nurminen et al., 2024; Pitidis et al., 2024). The process also reduced the risk that digital training would become detached from participants' actual economic circumstances.

The importance of this integrated diagnosis becomes clearer when compared with conventional digitalization interventions that focus heavily on platform adoption or marketing skills. Digital tools may expand market access, but their effectiveness depends on entrepreneurs' ability to identify appropriate markets, interpret information about customers, and align digital activity with business objectives (Gao et al., 2023; Wu et al., 2024). Similarly, digital transformation may support sustainability when embedded in broader organizational and economic processes, but technology alone does not automatically generate resilient or sustainable outcomes (Guandalini, 2022; Philbin et al., 2022). The present intervention therefore treated digital capability, information capability, and local economic knowledge as mutually reinforcing dimensions.

The baseline results also provide an important foundation for interpreting subsequent changes because improvement in digital resilience should not be equated with short-term adoption of a particular platform. A participant who creates an online business profile but remains unable to interpret customer information or identify relevant local market opportunities has experienced technological adoption without necessarily developing resilience. Conversely, an entrepreneur who can systematically collect business information, identify changes in local demand, use digital channels selectively, and mobilize community networks demonstrates a broader form of adaptive capacity. This distinction reflects the literature's increasing emphasis on the organizational and managerial micro-foundations of digital transformation (Zahoor et al., 2023; Su et al., 2023).

Overall, the baseline stage established the substantive rationale for integrating data literacy with participatory economic mapping. The intervention was designed around the premise that vulnerable micro-entrepreneurs require both the capability to interpret information and a locally grounded information environment from which meaningful decisions can be made. This combination extends existing digital-literacy approaches by connecting individual learning with collective knowledge production, while the participatory mapping component ensures that the intervention remains anchored in community-defined economic realities. The resulting framework provides the analytical basis for evaluating whether capacity building can strengthen digital resilience as a community-level capability rather than merely increasing individual technology use.

Participatory Data Literacy and Digital Resilience Capacity Building

The training component translated the baseline findings into practical learning activities centered on the collection, organization, interpretation, and application of business information. Rather than presenting data literacy as an abstract technical competency, the intervention connected each learning activity to recognizable entrepreneurial situations, including identifying customer characteristics, monitoring sales patterns, recording business transactions, comparing product performance, and identifying changes in demand. This pedagogical approach is consistent with the literature emphasizing that digital literacy among small enterprises is strengthened when transformation is treated as an open and guided learning process (Coco et al., 2024). It also reflects the broader argument that digital resilience emerges from the interaction between technological resources and the capabilities of people who use them (Kumar et al., 2023; Tim & Leidner, 2023).

Table 3. Participatory data-literacy training structure

Training component	Practical activity	Intended capability	Output
Data identification	Identify useful business information	Data awareness	Business-data inventory
Data collection	Record customer, sales and product information	Data acquisition	Structured records
Data organization	Classify and summarize information	Data management	Simple business dataset

Training component	Practical activity	Intended capability	Output
Data interpretation	Identify patterns and changes	Analytical literacy	Basic interpretation
Data-based decisions	Connect evidence to business choices	Decision capability	Action plan
Digital resilience	Respond to disruption scenarios	Adaptive capability	Resilience strategy

The practical orientation of the training was particularly important because digital transformation literature increasingly distinguishes between technology acquisition and effective technology utilization. Entrepreneurs can possess smartphones, social media accounts, or digital payment facilities while still lacking the capability to interpret the information generated through those technologies. The training consequently emphasized the movement from access, use, interpretation, decision, rather than stopping at technical operation. This progression is compatible with evidence that digital literacy and managerial attributes jointly influence the micro-foundations of SME digital transformation (Zahoor et al., 2023).

The participatory character of the learning process also influenced the way digital resilience was conceptualized. Participants were encouraged to discuss business disruptions they had personally encountered and identify what information would have helped them respond more effectively. This generated a connection between digital literacy and resilience because data were framed as resources for anticipating and responding to uncertainty rather than simply as administrative records. Such an approach is consistent with the conceptual literature on digital resilience, which emphasizes adaptive capabilities rather than static technological readiness (Tim & Leidner, 2023).

The intervention further encouraged participants to compare individual experiences with collective evidence. A business owner might know that customers had declined, for example, but collective data discussion could reveal whether the decline was specific to one enterprise, a product category, a particular location, or a broader local demand pattern. The ability to distinguish these possibilities represents an important transition from intuitive business management toward evidence-informed entrepreneurial decision-making. Han and Trimi (2022) similarly emphasize the value of data-oriented technologies for strengthening collaboration and information-based SME practices.

Table 4. Digital resilience capability assessment

Capability	Evidence of capability	Evaluation focus
Information awareness	Identifies relevant business information	Relevance
Information recording	Maintains structured records	Consistency
Information interpretation	Explains simple trends/patterns	Accuracy
Digital decision-making	Uses information to formulate action	Applicability
Risk awareness	Identifies digital/business risks	Anticipation
Adaptive response	Proposes alternative digital strategies	Resilience
Collaborative learning	Shares and validates information	Community capability

The training process also addressed barriers identified in the digital transformation literature, including limited confidence, insufficient skills, organizational constraints, and uncertainty about the practical value of digital tools (Rupeika-Apoga & Petrovska, 2022; Šimberová et al., 2022). Instead of treating these barriers as individual deficiencies, the intervention used peer learning and mentoring to reduce the dependence of participants on external technical assistance. This distinction matters because sustainable capacity building requires participants to develop sufficient confidence to continue using the acquired capabilities after the formal intervention has ended.

The results of the capacity-building process should consequently be interpreted in terms of capability development rather than simple training completion. A training session can be considered

meaningful only when participants demonstrate an increased ability to apply knowledge to their own businesses, interpret information independently, and connect digital resources with concrete economic decisions. This principle corresponds with findings that digital transformation is more likely to create value when organizational readiness, leadership, and self-efficacy are aligned with technological opportunities (Malodia et al., 2023). The mentoring stage reinforced this transition by allowing facilitators to address participant-specific barriers that could not be resolved through standardized instruction.

An additional outcome concerned the social dimension of digital resilience. Participants were encouraged to share digital practices, compare challenges, and identify complementary resources among local businesses. Such interactions transformed digital literacy from an individually possessed skill into a partially shared community resource, potentially reducing dependence on isolated trial-and-error learning. This is consistent with research suggesting that digital transformation can generate broader collaborative benefits when information and technological capabilities are connected through networks rather than confined to individual firms (Han & Trimi, 2022).

The integrated training also reinforced the relationship between digital capability and sustainability. Digitalization can contribute to sustainability when businesses use technology to improve efficiency, market responsiveness, resource management, and broader economic performance, although these outcomes depend on how digital capabilities are embedded within business practices (Miranda et al., 2024; Ozturk et al., 2024). Participants were therefore encouraged to consider whether a proposed digital practice reduced unnecessary costs, improved market reach, strengthened customer relationships, or increased business adaptability. This framing prevented digitalization from becoming an end in itself.

The intervention ultimately positioned participatory data literacy as a foundation for community-level digital resilience. Its principal contribution was not the introduction of a particular application but the development of a repeatable learning process in which entrepreneurs identify information needs, collect relevant evidence, interpret that evidence, and translate it into adaptive action. This logic complements evidence linking digital adoption with SME performance while recognizing that performance effects depend on the capabilities surrounding technology use (Gao et al., 2023; Wu et al., 2024). The resulting capacity-building model therefore connects digital literacy with decision-making, collaboration, and resilience rather than treating these domains as separate intervention targets.

Participatory Local Economic Mapping and Community Knowledge Production

The second major component of the intervention transformed dispersed community knowledge into a structured representation of the local economic environment. Participants identified business locations, product categories, suppliers, customer concentrations, complementary businesses, transportation connections, community facilities, and areas with perceived market potential. The purpose was not merely geographic visualization but the creation of a shared analytical representation through which entrepreneurs could examine relationships between their businesses and the surrounding economic ecosystem. Participatory mapping research supports this orientation by demonstrating that local actors can contribute valuable spatial knowledge while simultaneously developing stronger understandings of their own environments (Denwood et al., 2022; Nurminen et al., 2024).

Table 5. Local economic mapping variables

Mapping category	Variables documented	Community relevance
Enterprise locations	Business position and activity type	Spatial distribution
Product clusters	Product/service categories	Complementarity and competition
Suppliers	Source and accessibility	Supply-chain resilience
Customers	Main customer areas	Market reach
Infrastructure	Roads, facilities, connectivity	Accessibility
Economic opportunities	Potential commercial areas	Market expansion
Constraints	Barriers and underserved areas	Intervention targeting

Mapping category	Variables documented	Community relevance
Community assets	Institutions and local networks	Collective support

The mapping exercise demonstrated the value of combining spatial information with participants' experiential knowledge. Formal datasets may provide business counts or geographic boundaries, but they rarely capture informal supplier relationships, changing customer flows, perceived accessibility, or locally recognized economic opportunities with sufficient granularity. Participatory mapping makes these forms of situated knowledge visible and discussable, while digital tools can subsequently make the information easier to update and analyze. Denwood et al. (2023) highlight the potential of accessible participatory mapping approaches to improve the usability of community-generated spatial information without necessarily sacrificing analytical potential.

A critical element of the mapping process was the validation stage. Participants reviewed mapped information and discussed discrepancies between individual perceptions and collective observations, thereby reducing the risk that a map would simply reproduce the assumptions of the most vocal participants. This process is consistent with evidence that participatory mapping requires careful attention to how knowledge is generated, whose knowledge is represented, and how participation affects the resulting spatial product (Laituri et al., 2023). The map therefore became not only an output but also a mechanism for negotiating and validating community knowledge.

Table 6. Community economic map outputs

Output	Description	Intended use
Business distribution map	Spatial distribution of participating enterprises	Visibility and networking
Product map	Location by product/service category	Market analysis
Supplier network	Key supply relationships	Risk identification
Customer-area map	Main market areas	Market targeting
Opportunity map	Potential growth locations/segments	Expansion planning
Constraint map	Infrastructure and access barriers	Community advocacy
Resource map	Community institutions/assets	Partnership development

The mapping process also revealed why spatial context is important for digital resilience. Digital channels can theoretically expand market boundaries, but entrepreneurs remain influenced by physical distribution systems, local customer behavior, supplier accessibility, and community networks. Digitalization therefore complements rather than completely replaces territorial economic relationships. This interpretation is consistent with research demonstrating that digital transformation can contribute to sustainable SME development while remaining embedded in broader organizational and contextual conditions (Guandalini, 2022; Ozturk et al., 2024).

The mapping component further encouraged participants to recognize economic interdependence among local enterprises. Businesses that initially appeared to compete may share suppliers, customer groups, transportation routes, or promotional opportunities, while complementary businesses may generate potential cross-selling or referral relationships. Such insights can support a transition from individually oriented entrepreneurship toward network-based community economic development. This corresponds with broader research emphasizing collaboration and shared information infrastructures as mechanisms through which SMEs can improve their capacity to respond to changing environments (Han & Trimi, 2022).

The participatory approach was particularly relevant for vulnerable entrepreneurs because conventional economic planning frequently privileges formally recorded businesses and standardized indicators. Informal or small-scale enterprises may possess substantial local knowledge but remain poorly represented in formal datasets, creating a mismatch between administrative information and lived economic conditions. Community-generated mapping can partially address this problem by allowing local actors to identify resources and relationships that are otherwise difficult to observe.

Ariyanto (2023) and Makailipessy et al. (2023) illustrate the relevance of participatory mapping for identifying local socioeconomic and territorial potential within Indonesian community contexts.

The mapping process also supported the development of a community information infrastructure. Once validated, the map can potentially be updated as new businesses emerge, customer patterns change, or infrastructure conditions evolve. This creates a foundation for continuing community learning rather than treating mapping as a one-time project output. Such continuity is important because resilience is inherently dynamic and requires the capacity to update knowledge as environmental conditions change.

The integration of participatory mapping with data literacy represents the central innovation of the intervention. Data literacy enabled participants to understand how information can support decisions, while mapping provided a concrete context in which information could be organized spatially and interpreted collectively. The two components therefore addressed complementary dimensions of resilience: analytical capability at the individual level and shared situational awareness at the community level. This combination extends conventional digital-literacy interventions by connecting technological capability with place-based knowledge and collective economic action.

Mentoring, Integration of Findings, and Implications for Community Digital Resilience

The mentoring phase functioned as the mechanism through which training knowledge was translated into participant-specific practice. Instead of assuming that completion of workshops automatically resulted in behavioral change, facilitators reviewed participants' business information, mapping outputs, digital practices, and proposed responses to identified constraints. This approach is important because digital transformation frequently involves organizational and behavioral adjustments that cannot be accomplished through one-off training sessions (Malodia et al., 2023; Rupeika-Apoga & Petrovska, 2022). Mentoring consequently served as a bridge between acquired knowledge and its practical application.

Table 7. Mentoring and follow-up activities

Mentoring focus	Participant activity	Expected output
Business data	Review business records	Improved data structure
Digital presence	Review digital business channels	More consistent digital use
Market information	Interpret local market evidence	Targeted market strategy
Economic mapping	Validate business/map information	Updated community map
Resilience planning	Develop disruption responses	Business contingency plan
Peer learning	Share practices and barriers	Community knowledge exchange

The mentoring process also enabled facilitators to distinguish between barriers that were primarily technical and those that were organizational or contextual. A participant might understand how to use a digital platform but remain unable to maintain it because of limited time, inconsistent records, uncertainty about customers, or insufficient integration with existing business routines. This distinction is consistent with evidence that digital transformation is shaped by multiple enabling and constraining factors rather than by technological capability alone (Zhang et al., 2022; Rupeika-Apoga & Petrovska, 2022). Mentoring therefore emphasized adaptation of practices to actual business conditions rather than standardized technology adoption.

A central outcome of the integrated process was the strengthening of participants' ability to connect business decisions with information generated from their own environment. The combination of individual data records and community economic mapping enabled participants to move between micro-level information and broader local patterns. For example, individual customer information could be interpreted alongside the spatial distribution of potential customer areas or complementary enterprises. Such integration strengthens the practical relevance of data literacy because information becomes connected to decisions that have immediate economic meaning.

The process also created conditions for collective resilience. When participants shared information about suppliers, market areas, infrastructure constraints, and digital practices, knowledge

previously held by individual entrepreneurs became more accessible to the wider group. This does not imply that all information should be publicly disclosed, particularly where commercial sensitivity exists, but it demonstrates the potential of appropriately governed knowledge-sharing mechanisms to strengthen community capacity. The principle is consistent with digital resilience research emphasizing organizational and network-level enablers of adaptive capacity (Kumar et al., 2023).

Table 8. Integrated community-resilience outcome framework

Resilience dimension	Capacity strengthened through intervention	Community-level implication
Anticipation	Recognition of market and digital risks	Earlier identification of threats
Absorption	Access to alternative information/resources	Reduced dependence on one channel
Adaptation	Use of data to modify business practices	Greater flexibility
Recovery	Identification of alternative markets/networks	Faster response capacity
Learning	Reflection and peer exchange	Cumulative community knowledge
Coordination	Shared economic mapping	Stronger local collaboration

The integrated approach also provides a different interpretation of digital readiness. Readiness is often assessed through infrastructure, technology ownership, or willingness to adopt digital tools, but these indicators do not necessarily capture whether entrepreneurs can use information strategically. The present intervention conceptualizes readiness as a combination of access, competence, interpretation, application, and adaptive capacity. Such an interpretation is consistent with research emphasizing that digital transformation requires organizational preparedness and human capabilities alongside technological resources (Anatan & Nur, 2023; Coco et al., 2024).

The findings further reinforce the relationship between digitalization and economic sustainability. Digital technologies can improve access to customers, information, and transactions, but sustainability depends on whether these capabilities contribute to viable business routines and adaptive economic practices. The intervention therefore emphasized locally relevant and relatively accessible digital practices rather than encouraging participants to adopt technology for its own sake. This approach is compatible with evidence that digitalization can facilitate economic and environmental sustainability when integrated into broader business strategies (Miranda et al., 2024; Avelar et al., 2024).

The community dimension is particularly significant because vulnerable entrepreneurs may experience structural constraints that cannot be solved through individual training. Limited broadband access, geographic isolation, market concentration, and unequal access to information can continue to shape entrepreneurial outcomes even when individual digital skills improve (Marshall, 2024; Valentín-Sívico et al., 2023). Community-based interventions can partially address these constraints by generating shared knowledge, strengthening local networks, and identifying common priorities for future institutional support. This shifts the intervention from individual capacity building toward a broader community-development logic.

The results also demonstrate the importance of participation as an intervention mechanism rather than merely a methodological preference. Participants contributed to identifying problems, generating information, validating maps, interpreting findings, and developing responses, creating greater alignment between the intervention and local economic realities. This participatory structure responds directly to concerns that community mapping can become extractive when researchers collect local knowledge without returning analytical value to participants (Laituri et al., 2023). The process therefore positioned community members as co-producers of knowledge rather than passive recipients of externally designed solutions.

At the broader conceptual level, the intervention suggests that community digital resilience can be strengthened through the interaction of three capabilities: individual digital and data literacy, shared

local economic intelligence, and collective adaptive capacity. The first enables entrepreneurs to interpret and use information, the second provides contextual knowledge about the economic environment, and the third allows individuals to coordinate responses to changing conditions. This framework extends existing SME digital transformation perspectives by incorporating a stronger community and spatial dimension. It also provides a practical bridge between digital inclusion, participatory mapping, and local economic empowerment.

The overall contribution of the intervention therefore lies less in the introduction of a specific digital application than in the construction of a community-based learning and information system. Participatory data literacy gives entrepreneurs the skills to make sense of information, local economic mapping gives that information territorial meaning, and mentoring supports the conversion of knowledge into business practice. The combined model provides a potentially replicable approach for community organizations, local governments, universities, and development actors seeking to strengthen the resilience of vulnerable micro-enterprises. Its effectiveness, however, should ultimately be assessed through longitudinal evidence rather than short-term training outcomes alone, particularly because durable digital resilience requires continued practice, institutional support, and adaptation to changing local economic conditions.

CONCLUSION

This study demonstrates that strengthening digital resilience among vulnerable micro-entrepreneurs requires an approach that extends beyond the provision of digital tools and isolated technical training. The integration of participatory data literacy with local economic mapping created a community-oriented mechanism through which micro-entrepreneurs could interpret business information, identify locally relevant economic opportunities, recognize digital risks, and connect individual business decisions with the broader structure of the local economy. The findings indicate that resilience is more meaningfully developed when digital capabilities are embedded within practical decision-making processes and supported by locally generated knowledge rather than treated as a purely technological competency. The intervention consequently contributes an applied model in which data literacy, spatial-economic awareness, peer learning, and community participation operate as mutually reinforcing components of entrepreneurial capacity building.

The implications extend to both community development practice and the design of local economic empowerment programs. For practitioners and local institutions, the study suggests that digital inclusion initiatives should combine skills development with mechanisms that enable entrepreneurs to produce, interpret, and use information relevant to their own markets, suppliers, customers, and operating environments. Participatory mapping also provides a practical bridge between individual enterprise development and community-level planning because locally identified economic resources, business concentrations, market gaps, and connectivity constraints can become inputs for subsequent intervention design. At the conceptual level, the study positions digital resilience not merely as the ability of an enterprise to continue using digital technologies during disruption, but as a socially embedded capability involving knowledge, adaptive decision-making, local information, and collective support.

Several boundaries should be considered when interpreting the contribution of this study. The intervention was situated within a specific local community and focused on vulnerable micro-entrepreneurs, meaning that its applicability to larger enterprises, highly formalized business environments, or communities with substantially different digital infrastructures cannot be assumed without contextual adaptation. The participatory character of the intervention also means that the resulting economic map and learning outcomes are shaped by participants' knowledge, engagement, and ability to articulate local conditions, while the relatively limited intervention period constrains conclusions about long-term behavioral persistence and enterprise survival. These boundaries indicate that the study should be understood primarily as an applied community-based model rather than as a universally generalizable causal framework.

Future research can extend this contribution through longitudinal designs that examine whether improvements in data use, digital decision-making, market adaptation, and community connectivity are sustained after formal mentoring ends, while comparative studies across rural, peri-urban, and urban communities could examine how institutional conditions and digital infrastructure influence the effectiveness of participatory resilience-building. Subsequent research could also integrate geospatial

indicators, transaction-level business records, digital-platform analytics, and network measures to examine more systematically how individual entrepreneurial resilience interacts with community-level economic structures. For the wider public, the contribution lies in demonstrating that digital empowerment can be organized around accessible local knowledge rather than depending exclusively on sophisticated technology or external expertise, allowing community members to participate in identifying economic assets and vulnerabilities that directly affect their livelihoods. This perspective provides a practical foundation for community organizations, local governments, educational institutions, and development practitioners seeking more inclusive approaches to digital transformation and local economic strengthening.

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