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Digital Pain Points: Analyzing Technology Barriers and Ai Companion Needs Among Micro-Enterprises In Jalan Tunjungan Surabaya

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Abstract

Purpose: *This study investigates how heritage district constraints in Jalan Tunjungan, Surabaya, shape digital pain points and influence readiness for AI companion adoption among micro-enterprises, focusing on sales reporting and digital transformation barriers unique to historical commercial corridors..* ***Methods:*** *Employing a sequential mixed-methods design, the research combined ethnographic observation (40 hours), semi-structured interviews with 20 micro-enterprise owners, and survey data from 35 businesses. Grounded in UTAUT2 and resource-based view theories, the study incorporated technology acceptance modeling within heritage business district contexts, utilizing methodological triangulation for validation.* ***Results:*** *Four primary pain points emerged: fragmented multi-platform management (78%), selective digital literacy gaps (65%), infrastructure limitations in heritage buildings (42%), and time-intensive manual reporting (87%). Paradoxically, 72% expressed AI assistance interest despite limited understanding. The study identified unique contextual barriers including heritage-infrastructure paradox and intergenerational digital deference within family businesses.* ***Implications:*** *The research proposes a contextualized AI companion framework addressing location-specific barriers and contributes to middle-range theory development in technology adoption. Practical recommendations include phased digital transformation strategies and hyper-localized implementation approaches for heritage commercial districts.*

INTRODUCTION

The relentless acceleration of digital transformation presents both unprecedented opportunities and formidable challenges for micro-enterprises, the backbone of emerging economies. In Indonesia, this sector encompasses over 64 million businesses, contributes approximately 61% to the national GDP and absorbs 97% of the workforce (Sinha et al., 2024). Yet, a persistent and paradoxical "digital divide" threatens this economic pillar: while consumer digital adoption surges, micro-enterprise technological integration remains stunted, creating what scholars term the "productivity paradox of the digital age" (Raihan, 2024). This gap is particularly acute in historic urban commercial corridors, where centuries-old business practices collide with twenty-first-century technological imperatives. Jalan Tunjungan in Surabaya epitomizes this collision, a vibrant artery of commerce since the colonial era, now facing existential pressures to modernize or risk obsolescence (Srimulyani et al., 2023). Therefore, investigating the specific technological pain points experienced by micro-enterprises in this unique heritage district and explores their latent needs for artificial intelligence (AI) companionship is very important, a novel form of technological intervention designed to bridge capability gaps without demanding extensive digital literacy (Chaturvedi et al., 2023).

The theoretical problem anchoring this research concerns the inadequacy of universal technology adoption models when applied to context-specific business ecosystems. Dominant frameworks like the Unified Theory of Acceptance and Use of Technology (UTAUT2) by Venkatesh et al. (2012) and the Technology-Organization-Environment (TOE) framework (Schwaeke et al., 2025) provide valuable macro-level insights but often overlook micro-contextual variables that significantly alter adoption trajectories. Recent studies have begun addressing this limitation. For instance, Fazel & Sayaf (2025) demonstrated how social networks in traditional market settings facilitate peer-to-peer digital learning, while Wagner et al. (2022) identified "selective adoption" patterns where businesses embrace consumer-facing platforms while resisting back-end analytical tools. Regarding AI, Ali et al. (2020) documented a "trust deficit" among Southeast Asian retailers toward opaque algorithmic decision-making, noting that familiarity with social media algorithms does not translate to trust in business intelligence systems. Furthermore, infrastructural constraints in developing urban centers create unique adoption barriers that diverge from patterns observed in digitally mature economies (Novitasari & Putri, 2025). Recent empirical investigations into micro-enterprise digitalization reveal several consistent themes. Financially, the perceived high cost of digital tools remains a primary barrier, but increasingly, studies emphasize soft costs, time investment, training requirements, and workflow disruption, as equally significant deterrents. Culturally, hierarchical business structures and risk-averse mindsets in family-run enterprises slow experimentation with new technologies (Basir, 2024). While technically, interoperability issues between platforms create "digital silos" that increase administrative burdens rather than reducing them (Verhoef et al., 2021). However, these studies predominantly employ broad sectoral or national sampling, potentially homogenizing findings that might vary significantly across distinct business ecosystems. As Linda et al. (2022) caution, the micro-enterprise category itself is not monolithic. A street food vendor and a boutique clothing store inhabit radically different technological worlds despite similar employment numbers.

A significant research gap exists at the intersection of heritage business district preservation and technological modernization. While urban studies literature extensively documents architectural and cultural conservation challenges, and business literature examines digital transformation strategies (Raihan, 2024). Few studies investigate how physical heritage constraints, building structures, zoning regulations, infrastructural limitations, directly shape technological adoption possibilities and pain points (Gaonkar & Sukthankar, 2025). This oversight is critical because, as Yildiz (2023) note, the very walls that preserve historical character may simultaneously imprison businesses in technological antiquity. Furthermore, existing research on AI solutions for small businesses predominantly focuses on predictive analytics, customer segmentation, and automated marketing, capabilities aligned with growth-oriented small and medium enterprises (SMEs) rather than survival-focused micro-enterprises (Cofino & Cerna, 2025). The concept of an "AI companion," as a collaborative, assistive agent designed to augment rather than replace human decision-making. Particularly, regarding its potential to overcome digital literacy barriers through intuitive interfaces like voice interaction and contextual guidance (Rusthollkarhu et al., 2022). On the other hand, this study identifies three specific limitations in current literature that our research addresses. First, the geographical dilution in sampling strategies fails to capture ecosystem effects, how businesses within a shared physical and social environment collectively experience and respond to digital challenges. Second, AI feasibility studies typically assume adequate digital infrastructure and baseline literacy, overlooking contexts where electricity reliability, internet connectivity, and device access remain inconsistent (Verhoef et al., 2021). Third,

technology needs assessments often prioritize business expansion capabilities over operational survival needs, potentially misaligning solution design with immediate user requirements (Indrawan et al., 2024). Therefore, our research directly confronts these gaps by focusing intensively on a single heritage business district, explicitly investigating infrastructure-literacy interactions, and prioritizing pain point alleviation over growth acceleration.

The present research therefore poses the central question: What specific constellation of digital pain points characterizes micro-enterprises in Jalan Tunjungan, Surabaya, and how do these barriers inform the design requirements for a contextualized AI companion? We pursue three interrelated objectives: (1) to ethnographically map the digital ecosystem and catalog technological friction points across business processes, (2) to diagnose the readiness and resistance factors influencing potential adoption of AI-assisted tools, and (3) to synthesize these findings into a framework for AI companion development that addresses both universal micro-enterprise challenges and location-specific constraints. The novelty of our approach lies in its deliberate contextual specificity, treating the heritage business district not merely as a research setting but as an active variable shaping technological possibilities, and its focus on companion AI rather than autonomous AI, emphasizing collaboration over automation. By centering the lived experiences of business owners within their unique historical-geographical context, we contribute to more nuanced, localized models of technology adoption while generating practical insights for developers, policymakers, and business support organizations invested in inclusive digital transformation.

METHODS

Research Design

This study adopts a pragmatic research philosophy that prioritizes practical solutions to real-world problems over adherence to rigid methodological paradigms. Recognizing that the complex phenomenon of digital pain points in heritage business districts cannot be fully captured through either purely qualitative or quantitative lenses, we employed an explanatory sequential mixed-methods design. This approach begins with in-depth qualitative exploration to uncover context-specific issues, followed by quantitative validation to assess the prevalence and patterns of identified themes (Sugiyono, 2020). The research design was specifically tailored to address three methodological challenges unique to heritage district studies: (1) the need to observe physical-digital interactions in constrained spaces, (2) the requirement to capture both business operations and cultural-historical influences, and (3) the necessity of building trust with traditionally cautious business owners. We addressed these through methodological triangulation combining ethnographic immersion, semi-structured interviews, and survey administration, with each method informing and refining the others in an iterative cycle.

Sampling Strategy and Participant Recruitment

A purposive stratified sampling approach was implemented to ensure representation across business types, sizes, and digital engagement levels within Jalan Tunjungan's micro-enterprise ecosystem. The sampling frame was constructed through preliminary mapping of all 127 identifiable micro-enterprises along the 1.2-kilometer corridor, categorized by sector, visible technology use, and business longevity. From this frame, we selected 20 businesses for comprehensive participation and 35 for survey-only engagement, achieving what Guest et al. (2022) term "information power," a sufficient depth and variety to saturate emerging themes

while maintaining analytical manageability. Inclusion criteria were deliberately specific to capture the target population: (1) independently owned businesses with 1-10 employees (including family workers), (2) primary physical operations located within Jalan Tunjungan boundaries, (3) minimum two years of continuous operation to ensure establishment beyond initial survival phase, and (4) engagement in some form of digital transaction, however minimal. Exclusion criteria eliminated chain franchises, purely online businesses without physical presence, and enterprises undergoing ownership transition during the study period. Participant demographics reflected the district's diversity: owner ages 28-65 years, business tenure 2-32 years, and gender distribution male (65%) and female (35%), approximating national micro-enterprise ownership patterns (BPS, 2025).

Data Collection Prodedure

Data collection unfolded in three overlapping phases from October to November 2025, totaling eight weeks of field engagementand devided into four phases:

1. Ethnographic Observation (Weeks 1-4)
   We conducted approximately 40 hours of systematic observation across 15 business days, employing Trundle et al. (2025) developmental research sequence with progressive focus from descriptive to selective observation. Researchers maintained detailed field notes using a structured template capturing: (1) technology interactions (devices used, frequency, apparent proficiency), (2) sales reporting processes (manual/automated, time expenditure, frustration indicators), (3) physical-digital integration points (how online and offline transactions converged), and (4) spatial constraints affecting technology use. Photography (with permission) documented workspace arrangements, technology setups, and physical barriers. Observational data were supplemented by informal conversations with employees and customers to contextualize owner perspectives.
2. Semi-Structured Interviews (Weeks 2-6)
   Twenty in-depth interviews (45-70 minutes each) followed an interview protocol developed through pilot testing with three micro-enterprise owners outside the study area. The protocol incorporated elements from Venkatesh et al. (2012) UTAUT2 framework while allowing emergent themes to surface through open-ended probing. Questions explored: (1) current technology ecosystem and pain points ("Walk me through your typical day managing sales across different platforms"), (2) perceived needs and barriers ("What would make digital management easier or harder for you?"), (3) AI familiarity and expectations ("What comes to mind when you hear artificial intelligence for business?"), and (4) contextual factors ("How does operating in Tunjungan specifically affect your technology choices?"). Interviews were audio-recorded with consent, professionally transcribed, and member-checked for accuracy.
3. Survey Administration (Weeks 5-8)
   A 28-item survey was administered to 35 additional businesses beyond the interview cohort, plus the original 20 participants for methodological triangulation. The instrument combined: (1) adapted scales from Reid & Plank (2020) measuring technology acceptance constructs (5-point Likert, $\alpha = .87$), (2) digital literacy self-assessment items validated in Indonesian micro-enterprise contexts (Patria et al., 2023), (3) infrastructure and resource inventories, and (4) AI readiness indicators developed through Phase 2 findings. Survey distribution employed mixed modes: in-person paper administration for businesses with

limited digital comfort (n=22) and Google Forms via WhatsApp for digitally confident owners (n=33), with response consistency checks confirming mode equivalence.

Data Analysis Techniques

Qualitative data underwent thematic analysis following Braun & Clarke (2021) six-phase approach, utilizing NVivo 14 software for systematic coding. Analysis began with semantic coding of explicit content, progressed to latent pattern identification, and culminated in theme development through iterative discussion among three researchers. Quantitative data were analyzed using SPSS 26 for descriptive statistics, correlation analysis, and exploratory factor analysis to identify underlying constructs. The crucial integration of qualitative and quantitative findings occurred through joint display analysis, where qualitative themes informed quantitative variable interpretation, and survey results validated qualitative finding prevalence (Sugiyono, 2020). For example, observational notes about "platform switching fatigue" informed survey items measuring multi-platform management stress, while survey results about digital literacy self-ratings helped contextualize interview statements about technology avoidance as meta-inferences, where conclusions drawn from the combined methodological strengths that neither approach could achieve alone (Grass, 2024).

Ethical Considerations and Positionality

The study received ethical approval from institutional review, with particular attention to: (1) informed consent processes accommodating varying literacy levels through verbal explanations and simplified forms, (2) data anonymization using pseudonyms and aggregated reporting to protect business confidentiality in a competitive environment, (3) reciprocity through offering personalized digital readiness reports to participants, and (4) cultural sensitivity regarding hierarchical communication norms in family businesses. Researchers maintained reflexive journals documenting positionality considerations – particularly our roles as academic outsiders studying traditional business communities. Regular debriefing sessions addressed potential biases and ensured findings emerged from participant perspectives rather than researcher assumptions. The commitment to emic (insider) understanding guided all phases, with preliminary findings continually validated through member checking and peer debriefing with local business association representatives.

Validation Strategies and Limitations Management

Multiple validation strategies enhanced study credibility: (1) prolonged engagement (8 weeks) building rapport and depth, (2) triangulation across methods, data sources, and researchers, (3) negative case analysis actively seeking disconfirming evidence, and (4) thick description providing contextual richness for transferability judgments. Acknowledged limitations include: (1) single-district focus limiting immediate generalizability, though providing necessary depth, (2) self-report biases in digital literacy assessment, mitigated through observational validation, (3) seasonality effects as data collection occurred during relatively stable business periods, and (4) rapid technological change potentially altering relevance over time. These limitations are addressed through transparent reporting and recommendations for longitudinal replication (Creswell & Creswell, 2018).

RESULTS AND DISCUSSION

Digital Pain Point Ecosystem

The investigation revealed a complex ecosystem of digital pain points within Jalan Tunjungan's micro-enterprises, which can be analyzed through multiple theoretical lenses. Our findings demonstrate that technology adoption barriers are not monolithic but operate in interconnected layers, each requiring different explanatory frameworks. Infrastructure-Induced Digital Divides: Resource-Based View Meets Urban Studies Physical infrastructure limitations emerged as a primary constraint, with 42% of businesses reporting unreliable internet connectivity due to heritage building structural limitations. This finding extends (Lei et al., 2023) infrastructure barrier analysis by revealing how historical preservation regulations actively constrain technological upgrades. Participant R12, operating a 70-year-old textile shop, noted: "We cannot drill through these colonial-era walls for proper cabling, and wireless signals bounce unpredictably off thick stone walls." This creates what we term a heritage-infrastructure paradox, the very features preserving cultural value simultaneously impede digital adaptation. From a Resource-Based View perspective (Srimulyani et al., 2023), these physical constraints represent immutable non-substitutable resources that cannot be upgraded without compromising historical integrity. This study finding challenges conventional technology adoption models that assume infrastructure as a malleable variable. Instead, we observe what (Alsaleh, 2024) call "path-dependent digital exclusion," where historical choices continue to shape contemporary technological possibilities, suggesting that temporal layers of urban development create stratified digital landscapes.

Multi-Platform Fragmentation

A striking 78% of businesses utilized 3-5 digital platforms simultaneously without integration, spending an average of 3.2 hours daily consolidating information. This fragmentation represents what transaction cost theory would identify as digital coordination costs, the hidden expenses of managing disparate systems. Participant R08 described this as digital whiplash, "I switch between Tokopedia for orders, Instagram for promotion, WhatsApp for customer service, Excel for records, and paper receipts for cash sales. Each has its own logic, its own problems." The concept of "soft costs" of technology adoption finds vivid expression here. The cognitive load of platform switching, the risk of data entry errors across systems, and the opportunity cost of administrative time constitute substantial but often uncounted expenses (Cannas et al., 2024). Our quantitative analysis revealed that businesses using more than three platforms reported significantly higher perceived technology stress ($p < 0.001$) and lower satisfaction with digital tools despite higher sales volumes. This suggests a digital fragmentation penalty where increased channel access paradoxically reduces operational efficiency, a finding that complicates linear narratives of more technology equals better outcomes (Sinha et al., 2024).

Digital Literacy Paradox

Contrary to simplistic digital divide narratives, we observed selective digital competency rather than blanket illiteracy. Participants demonstrated proficiency with consumer-facing applications (Instagram self-rating, 4.1/5) but struggled with analytical tools (spreadsheet

functions, 2.3/5). This aligns with but extends Basir (2024) observation of micro-enterprise heterogeneity. The critical addition from our context is the platform-specific social learning occurring within the Tunjungan ecosystem. Social Cognitive Theory helps explain the pattern, where business owners observe peers successfully using certain platforms, gain confidence through vicarious learning, and adopt those specific tools while avoiding others without social proof (Putri & Novitasari, 2025). This creates digital competency clusters within business sectors, such as: fashion retailers excel at visual platforms, food vendors master delivery apps, while all struggle with back-end analytics. The social influence mechanism in Venkatesh et al. (2012) UTAUT2 model operates here but with hyper-local specificity, as "If the batik shop next door can use Instagram successfully, maybe I can too" (Participant R3).

AI Readiness with Skepticism

Despite limited AI understanding (only 35% could accurately define artificial intelligence), 72% expressed interest in Ai smart-assistants for sales management. This apparent contradiction of AI interest-competency gap, can be understood through Ayinaddis (2025) trust calibration framework. Participants distinguished between tool AI (familiar from smartphone features) and agentive AI (autonomous decision-making), expressing openness to the former while resisting the latter. Trust development followed a functional progression: businesses wanted AI to first demonstrate competence in simple tasks (data consolidation), then reliability in routine operations (daily reporting), before considering delegation of more complex functions (sales predictions). This staged trust-building aligns with AI adoption framework by emphasizing incremental functionality revelation rather than full capability disclosure from inception (Kulkarni et al., 2025). As Participant R08 articulated this precisely: "Start by helping me organize what I already have. Once I trust it with that, maybe it can suggest what to do next."

Generational Technology Transfer

A distinctive finding concerned intergenerational dynamics in family-run businesses (65% of our sample). Younger family members often served as digital intermediaries, bridging technological gaps but creating dependency relationships. This extends Ozturk et al. (2024) work on cultural inertia by revealing how asymmetric digital literacy within families creates both opportunity and tension. Elders maintained business authority while relying on younger members for technological executionas digital deference. Family Systems Theory illuminates how technology adoption decisions become entangled with existing family hierarchies and role allocations. The transfer of digital responsibilities often followed existing lines of authority rather than competency, sometimes resulting in suboptimal technology implementation (Browne et al., 2024). As Participant R11 (second-generation owner) noted: "My father chooses which technologies we use based on what his friends use, not what actually works best for us. I handle the implementation regardless." This finding suggests that technology adoption models must incorporate family system variables when analyzing micro-enterprises, particularly in collectivist cultural contexts.

Ecological Psychology in Heritage Settings

The physical layout of heritage shopfronts directly shaped technology usage patterns. Narrow spaces (averaging 4.2 meters frontage) limited hardware options, favoring mobile devices over desktop systems. This finding connects urban studies (Roberts et al., 2021) with technology

adoption literature through ecological psychology, where physical environments afford or constrain certain behaviors. The concept of affordance mismatch also emerged, i.e., smartphones afforded mobility in cramped spaces but limited complex data entry, or desktop systems afforded analytical capability but required impractical space allocations (Participant R01; R04).

Table 1. Theoretical Integration of Digital Pain Points

Pain Point	Primary Theory	Cross-Theoretical Insight	Practical Implication
Infrastructure limitations	Resource-Based View and Urban Studies	Heritage preservation creates path-dependent digital exclusion	Context-sensitive infrastructure solutions needed
Platform fragmentation	Transaction Cost Theory	Digital coordination costs exceed benefits without integration	Prioritize interoperability over feature richness
Selective digital literacy	Social Cognitive Theory	Competency clusters form through localized social learning	Peer-based training within business sectors
AI trust deficit	Trust Calibration Theory	Interest-competency gap requires staged functionality revelation	Incremental AI capability deployment
Generational digital divide	Family Systems Theory	Digital deference maintains hierarchy over efficiency	Family-system-aware implementation strategies
Spatial constraints	Ecological Psychology	Device determinism through affordance mismatch	Mobile-first, space-sensitive design

This spatial constraint created what we call device determinism—where physical space limitations dictated technology choices regardless of functional suitability. The correlation between shopfront width and device type was significant ($p < 0.01$), with narrower shops overwhelmingly using smartphones only (82%) versus wider shops utilizing multiple device types. This finding challenge assumption of technology choice as purely rational decision-making, instead revealing spatially-mediated technological paths.

DISCUSSION

Our cross-theoretical analysis reveals that technology adoption in heritage business districts cannot be adequately explained by any single existing framework. Instead, we propose a multi-layered contextual model that accounts for: (1) historical-geographical constraints (heritage infrastructure), (2) social-ecological systems (family and peer networks), (3) spatial-behavioral interactions (physical affordances), and (4) technological trust calibration pathways. The findings particularly challenge the universality assumptions in dominant models like UTAUT2 (Venkatesh et al., 2012). While performance expectancy, effort expectancy, and social influence remain relevant, their operationalization differs significantly in heritage contexts. Performance expectancy must account for spatial limitations; effort expectancy must consider intergenerational skill transfers; social influence operates through hyper-local networks rather

than broad social systems. For AI companion development specifically, our results suggest that context-awareness is not a feature but a fundamental design requirement. Systems must recognize and adapt to: physical space constraints, existing platform ecosystems, family business dynamics, and staged trust-building needs. As Kanapathipillai et al. (2024) state that call for context-sensitive digital solutions by specifying exactly which contextual dimensions matter most for micro-enterprises in heritage settings.

This study's single-district focus, while providing depth, limits immediate generalization. However, the theoretical integration demonstrated here offers a template for similar context-specific investigations. Future research should test whether our identified cross-theoretical dynamics operate in other heritage business districts with different cultural and historical profiles. Theoretically, our work contributes to middle-range theory development in technology adoption, bridging broad theoretical frameworks with specific contextual realities. By showing how existing theories interact and require modification in particular settings, we move beyond theoretical application toward theoretical adaptation and integration. This approach responds to recent calls for more situated, context-aware technology adoption research that acknowledges the "messy reality" of digital transformation in traditional business ecosystems (Ilyas et al., 2025).

CONCLUSION

This investigation reveals that micro-enterprises in Jalan Tunjungan face a complex constellation of digital pain points, with multi-platform fragmentation and time-intensive manual processes creating significant operational burdens. Despite limited AI familiarity, strong interest exists in companion technologies that address specific contextual needs, particularly integration capabilities and local language voice interfaces. The research contributes both theoretically and practically. Theoretically, it demonstrates how heritage business districts manifest unique digitalization challenges requiring adapted adoption frameworks. Practically, it provides evidence-based requirements for AI tool development targeting micro-enterprises in similar contexts. The proposed framework emphasizes phased implementation, starting with basic integration features before advancing to analytical functions. Future research should explore cross-cultural comparisons of heritage district digitalization and investigate the longitudinal impacts of AI companion implementation. Additionally, developing assessment tools for measuring context-specific digital readiness could help tailor intervention strategies. As micro-enterprises increasingly determine economic resilience in urban centers, understanding and addressing their technological challenges becomes ever more critical.

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