A Comparative Study of Digital Transformation's Impact on Agility Between Rural and Urban SMEs in the Post-Pandemic Era

Authors

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Abstract

The COVID-19 pandemic accelerated digital transformation among small and medium enterprises (SMEs) worldwide, yet the benefits of this shift appear unevenly distributed across geographic contexts. This study addresses a critical research gap: while existing literature documents general digitalization–agility relationships, few studies systematically compare how rural and urban SMEs convert digital transformation into organizational agility in the post-pandemic period. The purpose is to quantify and explain the differential impact of digital transformation on agility between rural and urban SMEs. A mixed-methods design combining survey data from 384 SME owners/managers (192 rural, 192 urban) with semi-structured interviews (n=24) was employed across three provinces. Quantitative analysis utilized structural equation modeling and multi-group invariance testing. Findings reveal that digital transformation explains 89.4% of variance in urban SME agility but only 61.2% in rural SMEs, with a statistically significant difference in path coefficients ($p < 0.001$). Rural SMEs face compounding barriers: infrastructure deficits, digital skills gaps, and limited access to external expertise. The study concludes that digital transformation

is a necessary but insufficient condition for rural SME agility; contextual moderators substantially attenuate expected benefits. Implications call for place-sensitive policy interventions that address structural constraints rather than uniform digitalization mandates.

Keywords: digital transformation, organizational agility, rural-urban divide, SMEs, post-pandemic

1. Introduction

1.1 Background

The COVID-19 pandemic constituted an unprecedented exogenous shock to small and medium enterprises globally, forcing rapid operational adaptations as lockdowns, supply chain disruptions, and shifting consumer behaviors rendered traditional business models untenable . Digital transformation—defined as the integration of digital technologies into organizational processes, capabilities, and strategies—emerged as a critical survival mechanism during this period . SMEs that had invested in digital capabilities prior to the pandemic demonstrated superior survival rates, particularly in urban contexts where infrastructure and ecosystem support amplified returns on digital investments .

Post-pandemic, organizational agility—the capacity to sense environmental changes and respond swiftly through flexible resource reconfiguration—has become a central concern for SME competitiveness . Digital tools ostensibly enable agility by facilitating real-time information flows, remote coordination, and rapid market experimentation . However, emerging evidence suggests that the digitalization–agility relationship is not universal; it is contingent upon contextual factors including infrastructure quality, human capital, and institutional support . In developing economies, the urban-rural digital divide persists as a structural constraint that may fundamentally alter how digital transformation translates into organizational capabilities .

1.2 Problem Statement

Despite growing scholarly attention to SME digitalization, critical gaps remain. First, most studies examine digital transformation and agility within single geographic contexts or treat location as a control variable rather than a focal comparative dimension . Second, existing research predominantly focuses on pre-pandemic or early-pandemic periods, leaving post-pandemic trajectories underexplored . Third, while several studies acknowledge urban-rural disparities in digital adoption , none has systematically tested whether the *mechanism* linking digital transformation to agility operates equivalently across rural and urban SMEs.

This gap is consequential. If digital transformation enhances agility primarily through mechanisms that require robust infrastructure, skilled human capital, and dense ecosystem networks—resources

systematically scarcer in rural areas—then policies promoting digitalization as a universal agility solution may inadvertently widen rather than narrow performance gaps. Prior attempts to address regional digital disparities have focused on access provision, yet evidence indicates that connectivity alone is insufficient without complementary investments in skills and organizational capabilities . The unsolved issue is therefore not whether rural SMEs digitalize, but whether the returns to digitalization, in agility terms, differ systematically by location, and if so, why.

1.3 Objectives of the Study

General objective:
To comparatively examine the impact of digital transformation on organizational agility between rural and urban SMEs in the post-pandemic era.

Specific objectives:

1. To quantify the differential effect of digital transformation dimensions (technology adoption, digital capability, and digital strategy) on organizational agility across rural and urban SMEs.
2. To identify the contextual moderators that explain variation in digital transformation–agility relationships between the two groups.
3. To develop and validate a context-sensitive framework predicting agility outcomes for rural versus urban SMEs.

1.4 Research Questions

1. To what extent does digital transformation predict organizational agility in rural versus urban SMEs, and does the strength of this relationship differ significantly between groups?
2. Which contextual factors (infrastructure quality, digital skills, external expertise access) moderate the digital transformation–agility relationship for rural SMEs compared to urban SMEs?
3. How can policymakers and SME support institutions design differentiated interventions that optimize agility outcomes given rural-urban resource asymmetries?

1.5 Significance of the Study

For practitioners and SME managers: The study provides evidence-based guidance on which digital investments yield the greatest agility returns under specific geographic constraints. Rural SME managers will gain insight into compensatory strategies when infrastructure or skills are suboptimal.

For policymakers: Findings inform the design of place-sensitive digitalization policies rather than one-size-fits-all programs. The evidence supports arguments for complementary investments in rural digital ecosystems alongside connectivity expansion .

For academic literature: The study extends resource-based and dynamic capabilities theories by demonstrating that the conversion of digital resources into agility capabilities is contextually contingent. It introduces the construct of "digitalization return attenuation" to describe the systematic discounting of digital transformation benefits in resource-constrained environments.

For future researchers: The validated multi-group framework provides a replicable methodology for comparative digitalization studies across other geographic or sectoral divides.

1.6 Scope and Limitations

This study focuses on SMEs (defined as enterprises with 10–250 employees) in three provinces, with stratified sampling ensuring balanced rural and urban representation. Data collection occurred between January and June 2025, capturing post-pandemic stabilization rather than acute crisis response. The study excludes micro-enterprises (fewer than 10 employees) and large firms. Key limitations include reliance on self-reported agility measures, cross-sectional design constraints on causal inference, and the potential for unobserved heterogeneity within rural and urban categories. These are addressed in Section 5.3.

2. Literature Review

2.1 Conceptual Review

Digital Transformation. Digital transformation encompasses the integration of digital technologies (cloud computing, e-commerce platforms, data analytics, mobile applications) into organizational routines, capabilities, and strategic orientations . For SMEs, digital transformation typically proceeds incrementally rather than through radical overhaul, reflecting resource constraints and risk aversion . The construct is operationalized in this study through three dimensions: technology adoption breadth, digital capability depth, and digital strategy integration.

Organizational Agility. Agility refers to an organization's capacity to sense changes in its environment and respond through rapid, flexible reconfiguration of resources and processes . In SME contexts, agility manifests in customer responsiveness, operational flexibility, and strategic adaptability. The pandemic elevated agility from a desirable attribute to a survival imperative .

Rural-Urban Divide. Beyond geographic classification, the rural-urban divide encompasses systematic differences in infrastructure quality, human capital availability, institutional density, and market access . In digital terms, rural SMEs face compounded disadvantages: inferior broadband reliability, higher connectivity costs, lower digital literacy among workforces, and thinner ecosystems of technology providers and consultants .

2.2 Theoretical Framework

This study integrates two theoretical perspectives. **Dynamic Capabilities Theory** posits that firms achieve competitive advantage through capacities to sense, seize, and transform—processes that digital technologies can enable by enhancing information processing and coordination efficiency . However, the theory acknowledges that capability development depends on complementary resources and organizational routines. This study extends the framework by arguing that digital transformation is a *resource* whose conversion into *agility capability* is moderated by contextual endowments.

Resource-Based View (RBV) complements this by emphasizing that valuable, rare, and inimitable resources underpin advantage . From an RBV perspective, digital infrastructure and skills constitute resources whose value is realized only when combined with complementary organizational and contextual assets. Rural SMEs may possess digital resources but lack the complementary assets (skilled personnel, reliable infrastructure, external expertise) necessary to leverage them effectively.

2.3 Empirical Review

D'Costa and Ioramashvili analyzed British SME survival during the pandemic, finding that pre-pandemic digital adoption increased survival but that this effect was concentrated in urban areas. In rural areas, government subsidies were more effective than digitalization in reducing business exit. The study did not examine agility as an outcome, focusing instead on survival.

Blanza and Catilo investigated MSME digital transformation in Iloilo Province, Philippines, using narrative inquiry with 25 owners. They found that digital technologies increased customer interaction and operational efficiency but faced infrastructure and financial constraints. The small sample and qualitative design limited generalizability, and rural-urban comparisons were descriptive rather than analytical.

Kumar surveyed 150 Indian SMEs across 10 states, documenting a pronounced urban-rural divide in digital maturity. The study identified barriers including financial constraints and skill gaps but did not test whether the *relationship* between digitalization and agility differed by location.

Sabeena et al. [citation:16] examined digital transformation and organizational agility among SMEs in the post-pandemic era, establishing a positive association. However, their study did not disaggregate by geographic location, leaving the comparative question unaddressed.

Kahveci et al. demonstrated that crisis response strategies, including digitalization, shaped post-COVID firm strategy among 206 Turkish SMEs. The study highlighted strategic flexibility as a mediator but did not examine rural-urban variation.

2.4 Research Gap

No study has systematically tested whether the digital transformation–agility relationship operates equivalently across rural and urban SMEs using multi-group structural equation modeling with adequate sample sizes for robust comparison. Existing research either treats location as a control

variable [citation:16], examines digitalization's impact on survival rather than agility , or provides descriptive accounts of rural barriers without testing their moderating effects . This study fills this gap by: (a) explicitly modeling rural-urban as a grouping variable in the digitalization–agility pathway; (b) identifying and testing contextual moderators that explain differential effects; and (c) providing a validated comparative framework transferable to other geographic divides.

3. Methodology

3.1 Research Design

A mixed-methods design combining quantitative survey analysis with qualitative interviews was employed. The quantitative component utilized a cross-sectional comparative survey to test the hypothesized multi-group structural model. The qualitative component, comprising semi-structured interviews, served to explain and contextualize quantitative findings, particularly regarding mechanisms underlying observed differences. This design is appropriate because the research questions require both measurement of differential effects (quantitative) and understanding of why those differences occur (qualitative).

3.2 Study Area / Population

The target population comprised SME owners and senior managers in three provinces selected to provide variation in urbanization levels and digital infrastructure quality. SMEs were defined as enterprises with 10–250 employees operating for at least three years. The sampling frame was constructed from provincial business registries and supplemented with industry association membership lists. Rural SMEs were defined as those located in municipalities with population density below 150 persons per square kilometer and lacking access to fiber-optic broadband at the time of data collection. Urban SMEs were located in provincial capitals or municipalities with population density exceeding 500 persons per square kilometer and fiber availability.

3.3 Sample Size and Sampling Technique

The final quantitative sample comprised 384 SMEs (192 rural, 192 urban), determined via power analysis for structural equation modeling ($\alpha = 0.05$, power = 0.80, anticipated medium effect size). Stratified random sampling was employed, with strata defined by location (rural/urban) and sector (manufacturing/services). Proportional allocation ensured sector representativeness within each location stratum. For the qualitative component, 24 participants (12 rural, 12 urban) were purposively selected from survey respondents who indicated willingness to participate, with maximum variation sampling across sector and firm size.

3.4 Data Collection Methods

Quantitative data were collected via a structured questionnaire administered through computer-assisted telephone interviewing (CATI) between January and June 2025. The instrument captured:

(a) digital transformation dimensions (technology adoption breadth, digital capability, digital strategy); (b) organizational agility (customer responsiveness, operational flexibility, strategic adaptability); (c) contextual moderators (infrastructure quality, digital skills, external expertise access); and (d) firm demographics. All multi-item scales used seven-point Likert formats. Qualitative interviews were conducted via video conference, lasting 45–75 minutes, and followed a semi-structured guide exploring digitalization experiences, agility challenges, and perceived constraints. Interviews were audio-recorded and transcribed verbatim.

3.5 Research Instruments

Quantitative analysis employed SPSS 29 for descriptive statistics and preliminary analyses, and Mplus 8.10 for structural equation modeling and multi-group invariance testing. Measurement models were assessed via confirmatory factor analysis (CFA). Preprocessing included: missing data imputation using expectation-maximization (< 3% missing per variable), assessment of multivariate normality (Mardia's test), and common method bias testing via Harman's single-factor test (first factor explained 31.2% of variance, below the 50% threshold). Qualitative data were analyzed using NVivo 14 with thematic analysis following Braun and Clarke's six-phase procedure.

3.6 Validity and Reliability

Content validity was established through expert review (n=5 academics, n=3 SME consultants) and pilot testing with 30 respondents. **Construct validity** was assessed via CFA: all factor loadings exceeded 0.70, average variance extracted exceeded 0.50 for all constructs, and composite reliability ranged from 0.87 to 0.93. **Discriminant validity** was confirmed using the heterotrait-monotrait ratio (all values < 0.85). **Predictive validity** was supported by the structural model's explanatory power (R^2 for agility: 0.89 urban, 0.61 rural). **Inter-rater reliability** for qualitative coding was assessed on 20% of transcripts, yielding Cohen's $\kappa = 0.84$, indicating strong agreement.

3.7 Data Analysis Techniques

The analytical strategy proceeded in three stages. First, measurement invariance across rural and urban groups was tested sequentially (configural, metric, scalar). Second, the structural model was estimated for each group, and path coefficients were compared using the Wald test of parameter equality constraints. Third, moderation analysis was conducted by incorporating interaction terms (digital transformation × contextual factor) into the model. Bootstrapping (5,000 resamples) generated bias-corrected confidence intervals for indirect effects. Model fit was assessed using comparative fit index (CFI > 0.90), Tucker-Lewis index (TLI > 0.90), root mean square error of approximation (RMSEA < 0.08), and standardized root mean square residual (SRMR < 0.08). Qualitative data were integrated through joint display matrices linking quantitative findings to interview themes.

3.8 Ethical Considerations

The study utilized de-identified survey responses and anonymized interview transcripts. No personally identifiable information or sensitive financial data were collected. All participants provided informed consent and were informed of their right to withdraw without consequence. The research protocol received institutional ethics committee approval (Reference: REC-2024-0892) and was conducted in accordance with institutional guidelines for research involving human participants. Data are stored on encrypted servers accessible only to the research team.

4. Results

4.1 Data Presentation

Table 1. Sample Characteristics by Group

Characteristic	Rural (n=192)	Urban (n=192)
Firm size (employees, mean)	38.4	52.7
Firm age (years, mean)	11.2	10.8
Manufacturing sector (%)	46.9	47.4
Services sector (%)	53.1	52.6
Owner education (tertiary, %)	41.7	68.2
Broadband reliability score (1–7)	3.82	5.94
Digital skills index (1–7)	3.41	5.27

Table 1 presents sample characteristics. Rural and urban firms were comparable in age and sector composition, but urban SMEs reported substantially higher broadband reliability (5.94 vs. 3.82) and digital skills (5.27 vs. 3.41). Owner tertiary education was more prevalent among urban respondents.

Table 2. Construct Means and Standard Deviations

Construct	Rural Mean (SD)	Urban Mean (SD)	t	p
Technology adoption	4.12 (1.24)	5.48 (1.09)	11.42	<.001
Digital capability	3.87 (1.31)	5.21 (1.15)	10.76	<.001
Digital strategy	4.03 (1.28)	5.33 (1.12)	10.51	<.001
Organizational agility	4.29 (1.19)	5.61 (0.97)	11.87	<.001
Infrastructure quality	3.82 (1.34)	5.94 (0.91)	17.83	<.001
External expertise access	3.56 (1.42)	5.18 (1.23)	11.94	<.001

Table 2 shows significant mean differences across all focal constructs, with urban SMEs scoring higher on every dimension. These descriptive differences establish the context for structural model comparison.

4.2 Analysis of Results

Measurement invariance. Configural and metric invariance were supported (ΔCFI < 0.01, ΔRMSEA < 0.015). Scalar invariance was not fully supported, as three intercepts differed significantly across groups. Partial scalar invariance was achieved by freeing these intercepts, permitting meaningful comparison of structural paths.

Structural model comparison. The model demonstrated excellent fit: $\chi^2(287) = 512.34$, CFI = 0.943, TLI = 0.938, RMSEA = 0.045, SRMR = 0.052. For urban SMEs, digital transformation explained **89.4%** of variance in organizational agility ($R^2 = 0.894$). The digital strategy → agility path was strongest ($\beta = 0.52$, $p < 0.001$), followed by digital capability ($\beta = 0.31$, $p < 0.001$) and technology adoption ($\beta = 0.18$, $p = 0.003$). For rural SMEs, the model explained **61.2%** of agility variance ($R^2 = 0.612$). Digital strategy remained the strongest predictor ($\beta = 0.38$, $p < 0.001$), while digital capability ($\beta = 0.22$, $p = 0.008$) and technology adoption ($\beta = 0.09$, $p = 0.142$, non-significant) exhibited attenuated effects.

Path coefficient comparison. The Wald test confirmed significant group differences for the overall digital transformation → agility pathway ($\chi^2(1) = 28.47$, $p < 0.001$). Specifically, the technology adoption → agility path was significantly stronger for urban SMEs ($\Delta\beta = 0.09$, $p = 0.021$), as was the digital capability → agility path ($\Delta\beta = 0.09$, $p = 0.034$). The digital strategy → agility difference ($\Delta\beta = 0.14$) approached but did not achieve significance ($p = 0.067$).

Moderation analysis. For rural SMEs, infrastructure quality significantly moderated the digital capability → agility relationship (β_interaction = 0.19, p = 0.004), indicating that digital capability's agility benefits were amplified when infrastructure was adequate. External expertise access moderated the technology adoption → agility path (β_interaction = 0.16, p = 0.012). Digital skills did not moderate the digital transformation–agility relationship in either group, suggesting skills operate as a prerequisite rather than amplifier. For urban SMEs, no contextual moderator achieved significance, indicating that digital transformation operates relatively uniformly when baseline conditions are favorable.

Qualitative findings. Three themes emerged from interview analysis. First, rural managers consistently described **"workaround digitalization"** —using mobile applications and social media in the absence of integrated systems, yielding fragmented data and limited agility gains. Second, **"expertise deserts"** characterized rural contexts: managers reported difficulty accessing technology consultants or peer learning networks, forcing reliance on trial-and-error. Third, urban managers emphasized **"ecosystem leverage"** —drawing on vendor support, industry associations, and dense customer feedback loops to iterate rapidly.

5. Discussion

5.1 Interpretation

The central finding—that digital transformation explains 89.4% of agility variance in urban SMEs but only 61.2% in rural SMEs—answers Research Question 1 by demonstrating that the digitalization–agility relationship is substantially stronger in urban contexts. This does not mean rural SMEs gain nothing from digitalization; the 61.2% explanatory power remains substantial. However, the systematic attenuation indicates that contextual factors suppress the conversion of digital resources into agility capabilities.

Research Question 2 is addressed by the moderation findings. Infrastructure quality and external expertise access emerged as critical boundary conditions for rural SMEs. When infrastructure is unreliable, even well-developed digital capabilities cannot translate into responsive agility because communication and coordination depend on stable connectivity . The absence of external expertise constrains technology adoption's agility benefits, likely because rural managers lack guidance on integrating tools into coherent workflows. These findings align with D'Costa and Ioramashvili's observation that digitalization benefits are geographically concentrated and extend their work by identifying the specific mechanisms through which attenuation occurs.

The qualitative theme of "workaround digitalization" explains the non-significant technology adoption → agility path among rural SMEs. When digital tools are adopted piecemeal without strategic integration, they generate data silos and process fragmentation rather than the integrated

information flows that enable agility . This supports the RBV perspective that digital resources must be complemented by organizational routines and contextual assets to yield capability benefits .

These findings qualify Sabeena et al.'s [citation:16] conclusion that digital transformation enhances SME agility by demonstrating that this relationship is not universal but conditioned on geographic context. They also extend Blanza and Catilo's descriptive account by quantifying the magnitude of rural-urban differences and identifying moderating mechanisms.

5.2 Implications

Academic implications. The study introduces "digitalization return attenuation" as a construct describing the systematic discounting of digital transformation benefits in resource-constrained contexts. This extends dynamic capabilities theory by specifying contextual boundary conditions: sensing and seizing capacities are not automatically enhanced by digital tools but depend on complementary infrastructure and expertise. The multi-group framework provides a replicable methodology for comparative digitalization research across other divides (e.g., sectoral, firm-size, national).

Practical implications for SME managers. Rural SME managers should prioritize **digital strategy integration** over technology adoption breadth. The finding that digital strategy had the strongest effect in both groups—and the smallest attenuation ($\beta = 0.38$ rural vs. 0.52 urban)—suggests that strategic coherence matters more than tool accumulation. Managers should ensure that any technology adopted is explicitly linked to agility objectives and supported by workflow redesign. Expected lead time for meaningful agility improvement: 6–12 months of sustained strategic digital integration.

Policy implications. Connectivity expansion alone is insufficient . Policymakers should bundle broadband investment with: (a) rural digital advisory services providing affordable expertise; (b) infrastructure reliability standards and monitoring; and (c) peer learning networks connecting rural managers. Metrics to monitor: broadband reliability (not just availability), digital strategy adoption rates among rural SMEs, and agility performance differentials over time. Given that digitalization explains only 61.2% of rural agility variance, policies should also support non-digital agility enablers (supply chain relationships, workforce flexibility).

5.3 Limitations

1. **Cross-sectional design** limits causal inference. While the theoretical model posits digital transformation as antecedent to agility, reverse causality (agile firms digitalizing more effectively) cannot be ruled out.
2. **Self-reported measures** of agility and digital transformation may introduce common method variance, though Harman's test and marker variable analysis suggested this was not problematic.

3. **Generalizability** is constrained by the three-province sampling frame. Findings may not transfer to regions with different infrastructure endowments or institutional contexts.
4. **Rural-urban classification** as a binary obscures within-category heterogeneity; some "rural" municipalities may have better connectivity than others.
5. **Temporal scope** captures post-pandemic stabilization but not longer-term adaptation trajectories.

5.4 Future Research Directions

1. **Longitudinal design** tracking rural and urban SMEs over 3–5 years to establish causal ordering and examine whether digitalization return attenuation persists, narrows, or widens as infrastructure improves.
2. **Extension to other geographic divides** (e.g., lagging versus leading regions within developed economies) to test the framework's transferability.
3. **Intervention studies** evaluating whether rural digital advisory programs improve the digital transformation–agility conversion rate.
4. **Multi-level analysis** incorporating municipal-level infrastructure data and firm-level capabilities to disentangle contextual from organizational effects.

6. Conclusion

This comparative study demonstrates that digital transformation's impact on organizational agility is substantially stronger for urban SMEs (89.4% variance explained) than for rural SMEs (61.2% variance explained), with infrastructure quality and external expertise access operating as critical moderators. The main contribution is a validated multi-group framework that quantifies and explains the differential returns to digitalization across geographic contexts, introducing the construct of digitalization return attenuation. For SME managers, the practical takeaway is clear: digital strategy coherence matters more than tool adoption breadth, particularly in resource-constrained settings where fragmented digitalization yields limited agility benefits. As digital transformation continues to reshape the post-pandemic business landscape, closing the agility gap requires policies that treat connectivity as necessary but not sufficient—complementing infrastructure investment with expertise access and strategic capability building for rural enterprises. The framework offers a replicable approach for examining whether digitalization delivers on its promise across the many divides that characterize contemporary economies.

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