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Article

Digital Infrastructure Utilization and the Competitiveness of Micro, Small, and Medium Enterprises (MSMEs) in Bukidnon, Philippines: A Correlational Study

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Abstract: This study examined the relationship between digital infrastructure utilization and the competitiveness of Micro, Small, and Medium Enterprises (MSMEs) in Bukidnon, Philippines, employing a descriptive-correlational research design. Data were gathered from 396 MSME owners and managers selected through stratified random sampling, using a validated survey instrument (Cronbach's $\alpha = 0.963$). Digital infrastructure utilization was measured across six indicators—e-commerce, digital payments, mobile banking, lending and credit technology, artificial intelligence and automation, and 5G and IoT—while MSME competitiveness was assessed through innovation capability, operational efficiency, and market responsiveness. Results showed that MSMEs were predominantly young, micro-scale, sole proprietorships concentrated in wholesale and retail trade. Digital infrastructure utilization was found to be utilized overall, with digital payments, 5G and IoT, and e-commerce more fully utilized than artificial intelligence and automation, and lending and credit technology. MSMEs rated themselves competitive, with operational efficiency scoring highest and innovation capability lowest. Pearson r analysis revealed a significant, strong positive correlation between digital infrastructure utilization and MSME competitiveness ($r = .676$, $p < .01$), with all six indicators showing significant positive relationships; e-commerce demonstrated the strongest association, while lending and credit technology showed the weakest. These findings affirm that digital infrastructure utilization is a significant correlate of MSME competitiveness, though its contribution varies by technology type. The study recommends targeted interventions to strengthen innovation capacity and expand access to underutilized technologies, particularly digital lending platforms, to help MSMEs in Bukidnon achieve more balanced and sustained competitiveness.

Keywords: digital infrastructure utilization, MSME competitiveness, e-commerce, digital payments

1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) worldwide face mounting pressure to remain competitive in markets increasingly shaped by digital technology, yet a persistent gap separates enterprises that have modernized their operations from those still relying on traditional practices. Technology adoption is widely recognized as a key driver of enterprise competitiveness, improving operational efficiency, product quality, and market reach (Sarita, 2025). However, a 2018 Bain & Company report found that only 16% of MSMEs in the ASEAN region had successfully transitioned into fully digital operations, exposing a persistent gap in digital transformation across the region. This uneven adoption places smaller enterprises at a structural disadvantage against larger competitors equipped with greater capital, more sophisticated pricing strategies, and wider market access (N90 Finance Corp., 2024), underscoring that competitiveness in the digital era is no longer solely a matter of product quality or price, but increasingly a function of an enterprise's capacity to adopt and utilize digital tools.

In the Philippine setting, these competitiveness concerns are magnified by the sheer scale and vulnerability of the MSME sector. As of the end of 2024, the Philippines had 1.2 million MSMEs, representing 99.6% of all registered establishments, employing about 6.3 million people or 66.6% of the national workforce, yet MSME lending accounted for only 3.9% of total bank loans despite an 8.4% year-on-year increase, reflecting persistent structural financing barriers according to the Asian Development Bank. The government's own development planning acknowledges that

MSMEs face a variety of interrelated issues spanning regulatory, financial, operational, technological, and market-related categories, prompting the Department of Trade and Industry to anchor its MSME Development Plan 2023-2028 on expediting digitalization, enhancing connectivity, and transitioning enterprises toward more service-oriented, technology-driven models. Despite these interventions, studies note that Philippine MSME digital adoption remains uneven, with barriers such as unreliable internet connectivity, financial constraints, and limited technical expertise continuing to restrict how fully enterprises can benefit from digital tools (Cordova et al., 2025).

These national patterns are further compounded at the regional and provincial level. In Bukidnon, the enabling environment for MSMEs is perceived as only moderately conducive overall, with significant variations across business types and municipalities. Moreover, most enterprises struggle to sustain operations beyond their first one to three years (Sudaria & Bagares, 2025).This is set against a regional economy that, while the largest in Mindanao and anchored in agriculture, food processing, and trade-related industries, continues to contend with infrastructure gaps; remote areas across the wider Mindanao region, including parts of Bukidnon, have historically depended on pilot satellite-internet projects and shared telecom-tower rollouts to address chronically limited connectivity (BIMP-EAGA, 2024). Recognizing this, national planners have identified infrastructure as central to achieving a more competitive, inclusive, and resilient Northern Mindanao, with the region hosting several ongoing flagship infrastructure projects under the current medium-term development agenda (Philippine Information Agency, 2025).

The connection between digital infrastructure and enterprise competitiveness is well established in the literature. Reliable connectivity and digital platforms allow MSMEs to overcome traditional operational barriers, with e-commerce platforms, digital payment systems, and cloud-based applications incorporated into business operations to enhance efficiency and serve wider markets (Cordova et al., 2025). At the national infrastructure level, the World Bank's ongoing support for the Philippines demonstrates this link directly: the Philippines Digital Infrastructure Project, approved in October 2024, invests in a national fiber optic backbone and connectivity for underserved communities, including areas in Mindanao, while complementary policy reforms aim to reduce the cost of internet access and expand digital opportunities to over 20 million Filipinos. Beyond connectivity, emerging tools such as artificial intelligence, the Internet of Things, and blockchain are increasingly viewed as sources of competitive advantage, enabling automated decision-making, real-time operational monitoring, and more secure transactions for enterprises able to adopt them (Sarita, 2025). Taken together, these findings suggest that an enterprise's competitiveness is closely tied not just to whether digital infrastructure exists in its locality, but to the extent to which the enterprise actually utilizes it in daily operations.

This study was anchored on this utilization-based conception of digital infrastructure. Rather than measuring the mere presence or availability of digital infrastructure, it examined the degree to which MSMEs in Bukidnon actively utilize six specific components: e-commerce, digital payments, mobile banking, lending and credit technology, artificial intelligence and automation, and 5G and IoT. These were examined in relation to three dimensions of MSME competitiveness: innovation capability, operational efficiency, and market responsiveness. Framing the inquiry this way treats digital infrastructure utilization as a behavioral and operational construct, one that captures how deeply digital tools have been embedded into an enterprise's daily practices, rather than treating digitalization as a binary condition of access versus non-access.

While national and Metro Manila-centered studies on MSME digitalization have grown substantially in recent years, comparatively little correlational research has focused specifically on provincial, agriculture-based economies such as Bukidnon, where infrastructure limitations, business informality, and geographic dispersion present a distinct competitive landscape from urban centers. Most existing Philippine literature on MSME technology either examines national policy frameworks (Department of Trade and Industry, 2024) or focuses on other regions such as Davao Oriental (Sarita, 2025), leaving a gap in empirical, correlational evidence specific to Bukidnon's MSME sector. It is within this gap that the present study situates itself. The main objective of this study, therefore, was to determine the relationship between digital infrastructure utilization and the competitiveness of MSMEs in Bukidnon, Philippines, with the goal of generating evidence that can guide local enterprises, industry stakeholders, and policymakers in designing more targeted digitalization strategies for the province.

2. Methodology

This study employed a descriptive-correlational research design to determine the relationship between digital infrastructure utilization and the competitiveness of Micro, Small, and Medium Enterprises (MSMEs) in Bukidnon, Philippines, without manipulating any variable or establishing causation (Creswell, 2014). The study was conducted in the Province of Bukidnon, Northern Mindanao, Philippines and involved 396 MSME owners and/or managers

selected through stratified random sampling to ensure proportional representation across municipalities. Data were gathered using a researcher-made structured survey questionnaire composed of three parts: business profile, digital infrastructure utilization (e-commerce, digital payments, mobile banking, lending and credit technology, artificial intelligence and automation, and 5G and IoT), and MSME competitiveness (innovation capability, operational efficiency, and market responsiveness), with responses measured using a five-point Likert scale (5 = Strongly Agree, 4 = Agree, 3 = Moderately Agree, 2 = Disagree, 1 = Strongly Disagree). The instrument underwent content validation by a panel of experts and was subsequently pilot tested among 30 MSME respondents not included in the final sample, yielding a Cronbach's alpha coefficient of 0.963, indicating excellent internal consistency and reliability (Taber, 2018).

Upon approval of the research protocol, questionnaires were administered to the identified respondents after securing their informed consent, and retrieved instruments were checked for completeness prior to encoding and statistical analysis. The gathered data were analyzed using frequency count and percentage to describe the business profile, mean to determine the level of digital infrastructure utilization and MSME competitiveness, and Pearson product-moment correlation coefficient (Pearson r) to determine the significance and strength of the relationship between the two variables, with significance set at the 0.05 level. Throughout the conduct of the study, ethical standards were strictly observed, including securing informed consent, ensuring the voluntary participation and confidentiality of respondents, and complying with the provisions of the Data Privacy Act of 2012 (Republic Act No. 10173).

3. Results and Discussions

3.1. Profile of Micro, Small and Medium Enterprises

Table 1 reflects the profile of micro, small and medium enterprises. Results showed that the surveyed MSMEs (N = 396) were predominantly young and micro-scale enterprises, with 82.8% having operated for three to ten years and only a marginal share exceeding thirty years in operation. Most enterprises (91.2%) employed only one to nine workers and were organized as sole proprietorships (76.7%), while wholesale and retail trade dominated the industry composition at 44.7%, followed distantly by other community, social, and personal service activities (11.4%) and the hotel and restaurant sector (15.9%).

Table 1: Profile of Micro, Small and Medium Enterprises

Indicator	Category	Frequency (N)	Percentage (%)
No. of Years in Operation	3 – 10 years 11 – 20 years	328 47	82.8 11.8
	21 – 30 years	17	4.3
	31 – 40 years	1	.3
	41 – 50 years	1	.3
	51 years above	2	.5
	TOTAL	396	100.0
No. of Employees	1 – 9 employees 10 – 99 employees	361 34	91.2 8.5
	100 – 199 employees	1	.3
	TOTAL	396	100.0
Ownership Structure	Sole Proprietorship	320	76.7
Ownership Structure	Partnership	47	11.9
	Corporation	25	6.3
	Cooperatives	4	5.1
	TOTAL	396	100.0
Industry Sector	Agriculture, Hunting and Forestry	19	4.8
Industry Sector	Arts, Entertainment and Recreation	5	1.3
	Banking and Financial Intermediation	5	1.3

Indicator	Category	Frequency (N)	Percentage (%)
	Construction	5	1.3
	Education	2	.5
	Electricity, Gas and Water	3	.8
	Health and Social Work	11	2.8
	Hotels and Restaurants	63	15.9
	Manufacturing	18	4.5
	Real Estate, Renting Activities	20	5.1
	Repair Services	13	3.3
	Transport, Travel agency and Communications	10	2.5
	Wholesale/Retail Trade	177	44.7
	Other Community Social and Personal Service Activities	45	11.4
	TOTAL	396	100.0

This profile depicted a business population still in its early operational stages, structured informally, and concentrated in trade rather than production, suggesting limited organizational capacity and resources typically needed to sustain more complex digital infrastructure investments. Such characteristics carry direct implications for the sector's digital readiness: micro and sole proprietorship enterprises, often lacking dedicated personnel or capital for technology adoption, are structurally more vulnerable to survival and scaling challenges, as reflected in national data showing that only six in ten exporting Philippine MSMEs survive their first year, dropping to fewer than four in ten by the fourth year (Bautista & Manzano, 2021). Gender-based disparities further compound this vulnerability, as women-led SMEs have been found to be smaller in scale and slower to adopt new technologies than their male-led counterparts (Daño-Luna & Caliso, 2019), while enterprise size itself has been identified as a key internal determinant of the capacity of Philippine businesses to adopt digital tools such as e-commerce (Quimba & Calizo, 2019). These findings imply that the MSME profile obtained in this study reflects broader structural realities that constrain digital transformation across the Philippine MSME sector as a whole.

3.2. Digital Infrastructure Utilization

As reflected in table 2 digital infrastructure utilization was found to be uneven across the six indicators examined, with digital payments obtaining the highest mean (3.70, “Agree/Utilized”), followed by 5G and IoT (3.59) and e-commerce (3.56), while mobile banking (3.46), artificial intelligence and automation (2.92), and lending and credit technology (2.78) fell under the “Moderately Agree/Moderately Utilized” category, yielding an overall mean of 3.34 described as “Utilized.” This pattern indicated that MSMEs in Bukidnon had more readily embraced transactional and connectivity-based digital tools than advanced, institutional, or finance-related technologies, suggesting that digital adoption in the province was being driven largely by immediate operational convenience rather than a deliberate, comprehensive digital transformation strategy. The implication of this gap is that while Bukidnon MSMEs have crossed the basic threshold of digital participation, they remain under-equipped to leverage higher-order technologies capable of generating deeper competitive gains, pointing to a need for targeted capacity-building around automation and formal digital credit systems rather than broad, undifferentiated digitalization programs.

Table 2: Digital Infrastructure Utilization of Micro, Small and Medium Enterprises

INDICATORS	Mean	Descriptive Rating	Qualitative Interpretation
Digital Payments	3.70	Agree	Utilized
5G and IoT (Internet of Things)	3.59	Agree	Utilized
E-commerce	3.56	Agree	Utilized
Mobile Banking	3.46	Moderately Agree	Moderately Utilized
Artificial Intelligence and Automation	2.92	Moderately Agree	Moderately Utilized
Lending and Credit Technology	2.78	Moderately Agree	Moderately Utilized
Overall Mean	3.34	Agree	Utilized

LEGEND

Rating Scale	Descriptive Rating	Qualitative Interpretation
4.51-5.00	Strongly Agree (SA) Highly	Utilized
3.51-4.50	Agree (A)	Utilized
2.51-3.50	Moderately Agree (MA)	Moderately Utilized
1.51-2.50	Disagree (D) Least	Utilized
1.00-1.50	Strongly Disagree (SD)	Not Utilized

This pattern is consistent with related findings; a qualitative study of Filipino microbusiness owners found that although digital literacy and internet access were generally present, e-payment adoption remained hampered by technical unreliability and limited trust, particularly among older or less tech-savvy owners (Pleno, 2024). Similarly, a systematic review of SMEs found that artificial intelligence adoption continued to be constrained globally by organizational readiness, infrastructure gaps, and financial capacity, mirroring the comparatively low utilization of AI and automation observed in this study (Yesuf et al., 2025). The weaker uptake of more complex digital tools further aligns with evidence that internal firm characteristics, such as size and existing ICT capability, significantly determine the extent of technology adoption among Philippine enterprises (Quimba & Calizo, 2019).

3.3. Competitiveness of Micro, Small, and Medium Enterprises

Table 3 presents the competitiveness of micro, small, and medium enterprises. MSME competitiveness was rated highest in operational efficiency (4.22, "Agree/Competitive"), followed by market responsiveness (4.15) and innovation capability (4.08), with an overall mean of 4.15 falling under the "Competitive" descriptive rating.

Table 3: Competitiveness of Micro, Small and Medium Enterprises

INDICATORS	Mean	Descriptive Rating	Qualitative Interpretation
Operational Efficiency	4.22	Agree	Competitive
Market Responsiveness	4.15	Agree	Competitive
Innovation Capability	4.08	Agree	Competitive
Overall Mean	4.15	Agree	Competitive

LEGEND

Rating Scale	Descriptive Rating	Qualitative Interpretation
4.51-5.00	Strongly Agree (SA)	Highly Competitive
3.51-4.50	Agree (A)	Competitive
2.51-3.50	Moderately Agree (MA)	Moderately Competitive
1.51-2.50	Disagree (D)	Least Competitive
1.00-1.50	Strongly Disagree (SD)	Not Competitive

This suggest that Bukidnon MSMEs perceived themselves as more capable of managing day-to-day operations efficiently and adjusting to market changes than of introducing new products, services, or business models, indicating that their competitiveness was being sustained more through operational discipline than through innovation. The comparatively lower innovation capability carries an important implication: operational efficiency alone may not be sufficient to maintain long-term competitiveness as market conditions and consumer expectations evolve, making it necessary for support programs to specifically strengthen innovative capacity rather than assume that efficient operations will naturally translate into innovation. This finding resonates with the broader literature, where digital technology mastery and market exploration have been identified as key strategies for building MSME competitive advantage, particularly when innovation lags behind operational and market-facing capabilities (Huda et al., 2024). Likewise, a bibliometric review of SMEs found that while AI-enabled tools strengthen operational efficiency and market responsiveness, translating these gains into genuine innovation remains a persistent challenge due to adoption

barriers (Yesuf et al., 2025). This is further supported by evidence that digital transformation significantly enhances open innovation performance primarily through the development of dynamic digital innovation capabilities, implying that innovation gains require more than digital tool availability alone (Qiu et al., 2025).

3.4. Correlation Analysis of Digital Infrastructure Utilization and MSME Competitiveness

The correlation analysis as depicted in Table 4, revealed that digital infrastructure utilization, as a whole, was significantly and strongly correlated with MSME competitiveness ($r = .676$, $p < .01$), with all six specific indicators yielding significant positive correlations: e-commerce (.630), digital payments (.587), 5G and IoT (.585), mobile banking (.566), artificial intelligence and automation (.556), and, notably weaker, lending and credit technology (.338). These results indicated that higher levels of digital infrastructure utilization were consistently associated with higher levels of MSME competitiveness, with e-commerce and connectivity-related tools showing the strongest associations, consistent with their higher utilization levels reported in Table 2, while lending and credit technology, the least utilized indicator, also showed the weakest link to competitiveness.

Table 4: Correlation analysis of digital infrastructure utilization and competitiveness of

Independent Variables Correlated with the competitiveness of MSME's	**Correlation Coefficient (r)**	**p-value**
Digital Infrastructure	0.676**	0.000
E-commerce	0.630**	0.000
Digital Payments	0.587**	0.000
Mobile Banking	0.566**	0.000
Lending and Credit Technology	0.338**	0.000
Artificial Intelligence and Automation 5G and IoT (Internet of Things)	0.556** 0.585**	0.000 0.000

**Correlation is significant at the 0.01 level (2-tailed)

This pattern implies that digital infrastructure investments already gaining traction among MSMEs, namely e-commerce, payments, and connectivity tools, represent the most immediately productive levers for enhancing competitiveness, whereas the weaker association for lending and credit technology suggests that its underutilization is limiting its potential contribution and warrants distinct policy attention geared toward improving MSME access to and trust in digital financial services. These findings align with prior evidence that digital transformation significantly drives innovation performance through enhanced dynamic capabilities (Qiu et al., 2025), that digital technology mastery contributes directly to competitive advantage in MSMEs (Huda et al., 2024), and that improving e-payment readiness among microbusiness owners can meaningfully strengthen their capacity to participate competitively in the digital economy (Pleno, 2024).

4. Conclusion

Based on the findings of the study, the following conclusions were drawn:

1. The MSMEs in Bukidnon were predominantly young, micro-scale, and informally structured enterprises, with the majority organized as sole proprietorships operating within the wholesale and retail trade sector for three to ten years. This profile suggested a business population still consolidating its operations rather than one positioned to absorb complex, capital-intensive digital transformation initiatives.

2. Digital infrastructure utilization among MSMEs was utilized overall, but markedly uneven across its components. Enterprises had substantially embraced consumer-facing and connectivity-based tools, particularly digital payments, 5G and IoT, and e-commerce, while artificial intelligence and automation, and lending and credit technology remained only moderately utilized. This indicated that digitalization in the province was being driven primarily by immediate transactional needs rather than a deliberate shift toward advanced or finance-related technologies.

3. MSMEs generally perceived themselves as competitive, with the strongest gains realized in operational efficiency and market responsiveness, and comparatively weaker gains in innovation capability. This implied that competitiveness in the sector was being sustained more through disciplined day-to-day operations than through the introduction of new products, processes, or business models.

4. Digital infrastructure utilization was found to be significantly and positively correlated with MSME competitiveness, both as an overall construct and across all six specific indicators. E-commerce showed the strongest association with competitiveness, while lending and credit technology showed the weakest, a pattern consistent with their respective levels of utilization. This confirmed that the more MSMEs utilized digital infrastructure, the more competitive they tended to be, thereby validating digital infrastructure utilization as a meaningful correlate of MSME competitiveness in Bukidnon.

4.1 Recommendations

Based on the conclusions drawn, the following recommendations are offered:

1. **For MSME owners and managers.** MSMEs are encouraged to sustain and further deepen their use of already well-adopted tools such as digital payments, e-commerce platforms, and connectivity technologies, while gradually building familiarity with underutilized tools such as artificial intelligence, automation, and formal digital lending and credit platforms, starting with low-cost, entry-level applications suited to micro and small-scale operations.

2**. For strengthening innovation capability.** Given that innovation capability was rated lowest among the competitiveness indicators, MSMEs and industry associations may consider investing in innovation-focused training, product or service development workshops, and exposure to digital tools that support experimentation, such as data-driven customer insight tools, rather than relying solely on operational efficiency to sustain competitiveness.

3. **For the Department of Trade and Industry (DTI) and local government units.** Given the low utilization of lending and credit technology despite its significant, if weaker, correlation with competitiveness, targeted programs are recommended to improve MSME access to and trust in digital lending platforms, including financial literacy campaigns, simplified onboarding processes, and partnerships with fintech providers, particularly for micro and sole proprietorship enterprises that may lack formal financial track records.

4. **For financial institutions and fintech providers.** Given that MSMEs in the study were predominantly small, informally structured, and trade-based, financial institutions may benefit from designing digital lending and credit products specifically tailored to these enterprise profiles, addressing common barriers such as collateral requirements, documentary demands, and limited digital literacy among owners.

5. **For expanding advanced digital infrastructure.** Considering that artificial intelligence and automation remained only moderately utilized, government agencies and private-sector partners are encouraged to continue investing in digital infrastructure and connectivity in Bukidnon, particularly in areas beyond urban centers, to reduce structural barriers that limit MSMEs from adopting more advanced technologies.

6. **For future researchers.** Future studies may consider expanding the scope to other provinces in Northern Mindanao for comparative analysis, employing regression or structural equation modeling to determine the predictive influence of specific digital infrastructure components on competitiveness, and conducting qualitative inquiry to better understand the specific barriers limiting MSME adoption of lending, credit, and AI-based technologies.

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