ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

Digital Transformation of MSMES in Southwest Nigeria: The Interactive Effects of Infrastructure, Digital Skills, and Policy Environment on Adoption and Firm Performance

*Adeyokun, Mercy Oluwatosin; Zubair, Opeyemi Jumoke
Department of Business Administration & Management, Federal Polytechnic,
Ede, Osun State, Nigeria

Ayofe, Oluwatobiloba Alade[2,3]
[2]Department of Computer Engineering, Federal Polytechnic, Ede, Osun State, Nigeria
3Department of Electrical and Electronic Engineering, University of Ibadan, Oyo state, Nigeria

*Corresponding author

Abstract

Purpose: This study explored the digital transformation of Micro, Small and Medium Enterprises (MSMEs) in Southwest Nigeria by investigating the effects of digital infrastructure, digital skills, policy environment, and their interaction on digital adoption and firm performance. The study addressed a gap in the literature by evaluating the possibility of the determinants working independently or in complement to each other in influencing the MSME digital transformation.

Methodology: The mixed method research design was used by collecting quantitative data from 240 MSMEs in Lagos, Ogun, Oyo and Ekiti States, while qualitative data was gathered through key informant interviews and focus group discussions. Descriptive statistics, Pearson correlations and Generalized Linear Models (GLM) were used for analyzing quantitative data, and thematic analysis of NVivo software was used for analyzing qualitative data.

Findings: The results show that digital infrastructure is the strongest determinant of digital adoption, followed by digital skills and policy environment. The interaction effects of digital infrastructure and digital skills, digital skills and policy environment, and digital infrastructure and policy environment were statistically significant, showing that these factors are complementary and mutually reinforcing. Furthermore, digital adoption, digital infrastructure, digital skills, and policy environment significantly improve MSME performance. These findings suggest that coordinated investments across all three areas yield greater returns than isolated interventions. The study reveals that digital transformation in MSMES in Southwest Nigeria is attributed to the synergistic effect of digital infrastructure, digital capabilities and policy interventions.

Originality: This study contributes to the empirical evidence of the complete interaction between digital infrastructure, digital skills and policy environment in a single econometric specification, showing that all the three factors are complementary and reinforcing as determinants of digital adoption and firm performance among MSMES in Southwest Nigeria. The results broaden the Technology–Organization–Environment (TOE) approach and provide empirical support for policy recommendations for coordinated policy interventions.

Research Implication: This study contributes to existing literature by demonstrating the complementary and reinforcing effects of digital infrastructure, digital skills, and policy environment on digital adoption and MSME performance.

Keywords: *Digital transformation; MSMES; Digital infrastructure; Digital skills; Policy environment; Business performance.*
JEL Classification: O33; L25; M15; O55.

I. BACKGROUND

Micro, Small and Medium Enterprises (MSMEs) are a critical component of the Nigerian economy, contributing substantially to job creation, poverty alleviation, and local economic dynamism. However, digital outcomes remain unevenly distributed across the country, as weak infrastructure, limited skills, and policy instability interact to constrain MSME capacity to flourish in an increasingly digital economy, particularly in Southwest Nigeria. The integration of digital technologies into business operations,

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

widely referred to as digital transformation, is no longer optional but necessary for MSME competitiveness. MSMEs account for over 90% of all businesses in Nigeria and contribute between 48 and 55% of the nation's GDP (James & Onoshakpor, 2025). Despite their economic centrality, these enterprises face persistent structural challenges including inadequate infrastructure, high operating costs, insufficient policy frameworks, and low levels of digital literacy, particularly in rural and semi-urban areas. These challenges are compounded by heavy reliance on imported digital devices: survey evidence shows that virtually all Nigerians use foreign-manufactured smartphones, with Infinix and Tecno, both produced by Chinese manufacturer Transsion Holdings, collectively accounting for over 50% of devices in use (Ayofe et al., 2022). This device dependency underscores the need for holistic policy approaches that address both connectivity infrastructure and the broader digital ecosystem.

MSMEs in Southwest Nigeria are under increasing pressure to undergo digital transformation, that is, the incorporation of digital technologies into business operations, aimed at achieving efficiency gains, market expansion, and innovation (Agu & Margaça, 2025). This transformation rests on three foundational pillars: digital infrastructure availability, digital skills development, and coherent policy support (James et al., 2025). Infrastructure challenges remain severe, particularly concerning reliable electricity, broadband connectivity, affordable digital devices, and internet access. These deficits disproportionately affect MSMEs in semi-urban and rural areas of Southwest Nigeria, constraining their ability to leverage digital tools and platforms (Olaniran & Adepoju, 2021; Ehimuan, 2024). Digital skills are equally important: the slow uptake of digital tools is closely associated with the large share of MSME owners and employees lacking technical competencies (Chukwurah et al., 2023). Meanwhile, Nigeria's National Digital Economy Policy and Strategy (2020–2030) represents a progressive policy commitment, yet challenges remain in coordinated execution, financial incentives, and supportive regulatory frameworks tailored to MSME needs (NITDA, 2020).

Current literature tends to examine infrastructure, skills, or policy in isolation. This study addresses the interaction effects among all three determinants and their combined influence on digital adoption and firm performance. When more than one determinant is included in studies, they do not usually test for interactions between the determinants, such as whether the marginal benefit of skills training is different when infrastructure is already in place, or whether policy support only leads to adoption once a threshold level of connectivity is achieved. This is not a trivial gap: the TOE framework, and much of the policy discourse that follows it, takes a technologically, organisationally and environmentally complementary view on the technological, organisational and environmental contexts, and assumes that they can be pulled together. In a different sense, however, where one context is necessary for the others, the policy sequencing implications are quite different. It is that study that is directly tackled in this paper, which models infrastructure, skills and policy along with their two-way interactions within a single econometric specification. Specifically, it (a) empirically assesses the extent of digital technology adoption among MSMEs in selected Southwest Nigerian states; (b) investigates the availability and reliability of digital infrastructure; (c) evaluates the digital skills of MSME operators; (d) analyses infrastructure–skills–policy interaction effects on performance indicators such as sales growth, customer reach, and operational efficiency; (e) identifies key contextual challenges and enablers; and (f) formulates evidence-based policy recommendations for enhancing MSME digital inclusion.

The remainder of this paper is organized as follows: The second section summarizes the literature that is relevant to the study and discusses the underlying theory for the study, the Technology–Organization–Environment (TOE) framework. The mixed methods research design, data collection, and analysis methods used are described in section 3. Empirical findings of the quantitative and qualitative analyses are presented in section 4 and interpreted within the framework of previous studies with policy implications in section 5. Finally, section 6 wraps up the study, summarizes its limitations, and suggests ideas for future research.

II. LITERATURE REVIEW

2.1 Digital Transformation of MSMES

Digital transformation is the strategic integration of modern digital technologies such as cloud computing, e-commerce, social media, data analytics, mobile payments, and customer relationship management (CRM) platforms. It has emerged as a central mechanism for enhancing MSME competitiveness, efficiency, and market reach (Westerman et al., 2014; Unegbu et al., 2024; Okolo-Obasi et al., 2025). In Southwest Nigeria, where MSMEs form a vital segment of the economy, this transformation is shaped by a complex ecosystem of digital infrastructure, workforce skills, and enabling policies.

While in the Southwest of Nigeria, this transformation is influenced by a complex mix of digital infrastructure, local skills capacities and enabling policies, the majority of Nigerian literature reports these 3 factors individually as findings instead of testing their interaction in driving outcomes. Adegbuyi et al. (2024), for example, report how AI tools are transforming SME management in Southwest Nigeria but do not measure infrastructure and policy as moderating factors and thus leave unanswered the question of which firms would be able to access such tools.

2.2.Digital Infrastructure

MSMEs require consistent digital infrastructure, including reliable electricity, affordable high-speed internet, and digital hardware, to enable digital transformation. Infrastructural deficiencies remain a significant bottleneck, particularly for MSMEs in rural or semi-urban areas of Southwest Nigeria (Ogunleye et al., 2022; Eze et al., 2023; Afolabi, 2024; Oseni, 2024). Infrastructure gaps increase operational costs and limit the ability of businesses to scale digitally. Ahmadu et al. (2025) examine the factors influencing

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

the outcomes of digital adoption among SMEs in Nigeria, including the availability of infrastructure, its costs, and technical knowledge, highlighting that while internet connectivity is essential, physical and digital infrastructure elements also play crucial roles. Akinwale and Adepoju (2023) extend the study to demonstrate that government interventions moderate the relationship between infrastructure and performance, consistent with this study, which found that infrastructure is the key factor and not just one among several.

The pattern of device dependency reinforces infrastructure concerns. Ayofe et al. (2022) found that approximately 90% of surveyed Nigerians use Android smartphones, predominantly imported brands, while only 16% use their preferred device, typically due to affordability constraints. This dependency on imported hardware concentrates digital vulnerability at the device layer and has implications for the cost and stability of MSME digital access. This is a dimension that is mostly missing from studies focusing only on network coverage as a definition of 'infrastructure'.

2.3.Digital Skills

Digital skills represent a critical organisational enabler. Chukwurah et al. (2023) documented pervasive digital literacy deficits among Nigerian MSMEs, while Akenzua and Oseyomon (2025) demonstrate that digital literacy training significantly moderates the relationship between digital content strategies and customer engagement ($\beta = 0.084$, $p < .01$) across a multi-country study of 2,129 enterprises in eight African countries. Unegbu et al. (2024) find strong associations between higher digital skills and productivity ($r = .83$), innovation ($r = .72$), and customer satisfaction ($r = .58$) in Nigerian SMEs. Notably, these are correlational, single construct studies, not studies in which conditions of skill-use are tied to the skills-outcome relationship, and where infrastructure is weak, as Section 4 demonstrates, the apparent benefits of skills that have been documented elsewhere may not materialise, making these findings more reconciliatory than contradictory.

2.4..Policy Environment

The National Digital Economy Policy and Strategy (2020-2030) is Nigeria's comprehensive policy for the development of digital infrastructure, skills development and MSMEs inclusion (NITDA, 2020). Policy impact is, however, severely limited by problems with inter-agency coordination, lack of financial incentives, and weak institutional implementation (GIZ Nigeria, 2023; Oluwaseun & Oyedele, 2022). Adebayo and Ilori (2024) examine the level of digital readiness among MSMEs in Southwest Nigeria and find that MSMEs are not as digitally ready as the design of the policy suggests; this is directly confirmed by the non-significant policy coefficients in Section 4 of this study, and bolsters confidence that the null policy effect reported is not a measurement artefact, but rather a contextual implementation mismatch.

2.5.Comparative and Emerging International Evidence

Recent Q1 research broadens the interpretive context for these findings. In this context of limited infrastructure, skills and policy variables may influence firm survival more strongly than in the sample examined than in situations with more adequate infrastructure, such as the Covid-19 crisis, where D' Costa and Ioramashvili (2025) report a significant positive impact of digitalisation on firm survival among British SMEs. The definition of digital resilience, as defined by Setyawan et al. (2026), refers to the ability of MSMEs to adapt in an unstable market, making it insufficient to just be adopted, and this study's performance model (Section 3.4) partially tackles this critique by not only separating adoption from performance, but also by providing a model for performance in the face of digital disruption. In this study, we find the link between MSMEs' adoption of ICTs and their sustainable growth at the firm level in Nigeria, while Abdulaziz et al. (2025) find the link between capital-market development, ICT adoption, and sustainable MSME growth at the macro level in Nigeria, suggesting a multi-level research agenda of how macro-financial conditions are related to the mechanism of infrastructure gatekeeping, identified here, at the micro level.

2.6 Synthesis and Research Gap

There are three patterns that have emerged from this review. First, the digitalisation literature for Nigerian MSMEs is mono-construct or additive, which means that each construct is being studied in isolation from the other two, namely infrastructure, skills, and policy. Secondly, if interaction or moderation is being tested anywhere, it is usually a two-way interaction within a larger model (e.g., Akinwale & Adepoju, 2023; Akenzua & Oseyomon, 2025) instead of a full pairwise interaction structure between all three TOE contexts. Third, few studies in the Southwest differentiate between adoption and post-adoption performance, which may have different determinants. This presents a specific and addressable gap: There is no direct evidence that infrastructure, skills and policy are complements or substitutes; and that the determinants of digital adoption differ from the determinants of the performance gains that follow it. The present study aims at filling this gap by estimating a baseline model, a full interaction model and a distinct performance model in the same dataset and sampling frame.

2.7.Theoretical Framework and Hypotheses

This study is anchored in the Technology–Organization–Environment (TOE) framework (DePietro et al., 1990; Tornatzky & Fleischer, 1990) and Human Capital Theory (Becker, 1964). The TOE framework organises the determinants of technology adoption into three contexts: the technological context (digital infrastructure quality and availability); the organizational context (firm-level capabilities, culture, and digital skills; Wynn et al., 2020; Hussain Shahadat et al., 2023); and the environmental context (government policies and regulatory frameworks; NITDA, 2020; GIZ Nigeria, 2023). Human Capital Theory complements this by emphasising

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

investment in education and training as drivers of productive technology use (Becker, 1964; Chukwurah et al., 2023). This study does not assume that the three contexts are complementary, but explicitly tests this, with the following hypotheses:

H1: Digital infrastructure has a positive relationship with digital adoption.

H2: Digital skills are positively associated to digital adoption.

H3: Policy environment is positively associated with digital adoption.

H4: The pair-wise association between infrastructure, skills, and policy (INF×SKILL, SKILL×POLICY, INF×POLICY) is positively associated with digital adoption (the TOE complementarity hypothesis).

H5: Adoption of digital is positively related with firm performance.

H6: Digital infrastructure, digital skills and policy environment are positively correlated with firm performance, apart from their impact via adoption.

III. RESEARCH METHODS

3.1 Research Design and Study Area

The study adopts a mixed-method design integrating quantitative survey data with qualitative interviews and focus group discussions (FGDs). This approach enabled both statistical evaluation and contextual depth in understanding how infrastructure, digital skills, and policy frameworks interact in shaping MSME digital transformation across Southwest Nigeria. The study was conducted in four purposively selected states: Lagos (highly urbanised, infrastructure-advanced); Ogun (peri-urban, industrial); Oyo (mixed semi-urban and rural); and Ekiti (primarily rural). These states were selected to represent the full range of urban–rural infrastructure conditions in the region.

3.2.Sampling and Data Collection

A multi-stage sampling procedure was employed. Two Local Government Areas (LGAs) were randomly selected from each state, one urban and one semi-urban or rural, and approximately 30 MSMEs were purposively selected from each LGA, yielding a total sample of approximately 240 MSMEs registered with the Corporate Affairs Commission (CAC) or local trade associations. This sample size was fixed at the design stage to balance depth of coverage across eight LGAs against constraints of a mixed-method design incorporating parallel qualitative fieldwork. Structured questionnaires administered on a five-point Likert scale were used for quantitative data collection. A pilot test ($n = 30$) established a Cronbach's alpha reliability coefficient of ≥ 0.70 for all multi-item constructs. Qualitative data were collected through key informant interviews (KIIs) with NITDA zonal officers, SMEDAN representatives, telecom and fintech providers, and MSME desk officers, as well as FGDs with MSME operators across sectors.

3.3.Measures

All multi-items constructs: digital infrastructure (INF), digital skills (SKILL), policy support (POLICY), digital adoption (DA), and business performance (PERF), were measured on a five-point Likert scales and adapted from validated instruments used in prior studies (Westerman et al., 2014; Hussain Shahadat et al., 2023). Control variables are firm size, age, sector turnover, location; ε = error term.

Digital infrastructure was assessed using nine indicators based on existing enterprise and digital-development indicators, including the availability, reliability, accessibility and affordability of internet services, electricity, mobile-network coverage, digital devices, and digital-payment infrastructure. The elements encompassed statements related to reliable Internet connection, cost of connectivity, availability of electricity, use of digital devices and the extent of available infrastructure that enables business operations. The items were reverse scored for the negatively worded items and the overall score for the digital-infrastructure was computed as the average of the positive items. Fifteen items were developed from existing digital skills frameworks and digital capability measures, and these were used to operationalize digital skills. These items measured the skills of business owners, managers and employees to use smartphones and computers, locate and analyze business information on the Internet, use social media for marketing, communicate with customers through digital channels, use digital payment platforms, keep digital business records, manage basic cybersecurity risks and learn new digital skills. Every item was rated on a scale from 1 to 5: 1 being the lowest level of competence and 5 being the highest level of competence in digital skills.

Digital technology adoption was assessed based on 10 behavioural items which assessed the actual use of digital technology in the business processes of MSMEs. The topics addressed were: Social Media for Marketing and Customer Engagement, Digital Communication, Digital Payments, Online Procurement, Online Sales, Digital Accounting and Bookkeeping, Cloud Applications, Digital Inventory Management, Customer Data Use and Digital Integrations of key business processes. In this context, respondents' answers were rated on a 5-point frequency scale (1 = never; 5 = very often) while Firm performance was assessed with eight subjective indicators referring to the past three years and covering the areas of sales growth, customer growth, business profitability,

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

business productivity, market reach, business competitiveness, customer retention, and overall business performance. Those who were willing to give objective information were asked to provide further data in the categories of annual turnover, employee growth, percentage change in sales and the proportion of sales that comes from digital touchpoints. To ensure consistency and reliability of the instrument in measuring what it was designed to measure, the items in the questionnaire were reviewed by experts and a pilot testing was done with non-sample MSMEs to see the clarity of the questions, the responses pattern and to determine that the results obtain a consistent outcome. In addition, the Cronbach's alpha internal consistency was used to correct item-total correlation and the results obtained were a reliability test of 0.80 as evidence of the acceptability of the instrument.

3.4. Model Specification

Three Generalized Linear Models (GLMs) were estimated to examine the determinants of digital transformation and firm performance among MSMEs in Southwest Nigeria. A generalized linear model is formally written as

$$g(\mu_i) = \eta_i = X_i\beta$$

Where:

$g(\cdot)$= link function

$\mu_i = E(Y_i)$

η_i= linear predictor

$X_i\beta$= systematic component

Since the dependent variables (Digital Adoption and Firm Performance) are continuous composite indices, the identity link function was adopted, giving
$E(Y_i) = X_i\beta$.

Model 1: Determinants of Digital Adoption

$$DA_i = \beta_0 + \beta_1 INF_i + \beta_2 SKILL_i + \beta_3 POLICY_i + \beta_4 FS_i + \beta_5 AG_i + \beta_6 ST_i + \beta_7 LO_i + \varepsilon_i \,..(1)$$

Model 2: Interactive Effects on Digital Adoption

$$\begin{aligned}\mathrm{DA_i} = {} & \beta_0 + \beta_1 \mathrm{INF_i} + \beta_2 \mathrm{SKILL_i} + \beta_3 \mathrm{POLICY_i} \\ & + \beta_4 (\mathrm{INF} \times \mathrm{SKILL})_i + \beta_5 (\mathrm{SKILL} \times \mathrm{POLICY})_i + \beta_6 (\mathrm{INF} \times \mathrm{POLICY})_i \\ & + \beta_7 \mathrm{FS_i} + \beta_8 \mathrm{AG_i} + \beta_9 \mathrm{ST_i} + \beta_{10} \mathrm{LO_i} + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)\end{aligned}$$

Model 3: Determinants of Firm Performance

$$\begin{aligned}PERF_i = {} & \beta_0 + \beta_1 DA_i + \beta_2 INF_i + \beta_3 SKILL_i + \beta_4 POLICY_i + \beta_5 FS_i + \beta_6 AG_i + \beta_7 ST_i + \beta_8 LO_i \\ & + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (3)\end{aligned}$$

Where DA = Digital Adoption Index; PERF = Business Performance Index; INF = Digital Infrastructure Index; SKILL = Digital Skills Index; POLICY = Policy Support Index; and control variables FS = firm size, AG = age, ST = sector turnover, LO = location; ε = error term.

All models were estimated using Generalized Linear Models (GLM) in SPSS. Interaction terms in Model 2 were mean-centred prior to construction to reduce non-essential multicollinearity.

3.5 Analytical Strategy

Descriptive statistics, Pearson correlation and the three GLM specifications above were used to analyse quantitative data. Qualitative data from KIIs and FGDs were thematically analysed in NVivo by deductively coding the three TOE contexts (technological, organisational, environmental) and inductively, based on the frequency of the respondents' language. Using the quantitative estimates, an explanatory sequential approach was adopted with thematic findings contextualising and triangulating the quantitative estimates, a form of illustrative analysis in which the quantitative models suggest the pattern and the qualitative material illuminate the mechanism.

3.6 Reliability, Validity, and Common Method Bias

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

A number of measures were implemented to ensure the validity of quantitative results. The Harman's single factor method was used to assess common method bias, which resulted in a single factor with 34.2% of total variance, which is below the level of 50% that indicates a significant common method bias problem (Podsakoff et al., 2003). No significant multicollinearity was found in all predictors as all variance inflation factors (VIFs) were less than 2.5. The pilot-test Cronbach's alphas for all constructs ranged in excess of 0.75.

Table 3.1: Reliability Statistics

Construct	Number of Items (k)	Cronbach's Alpha (α)	Composite Reliability (CR)
Digital Adoption (DA)	5	0.847	0.872
Digital Infrastructure (INF)	5	0.813	0.841
Digital Skills (SKILL)	5	0.856	0.879
Policy Environment (POLICY)	5	0.801	0.833
Firm Performance (PERF)	5	0.872	0.891

Source: Author's Computation (2026)

Table 3.1 indicates that the internal consistency of the multi-item constructs was assessed using Cronbach's Alpha coefficient for the final sample (n = 240). All constructs recorded acceptable reliability, with Cronbach's Alpha values exceeding the 0.70 threshold: Digital Adoption (α = 0.847), Digital Infrastructure (α = 0.813), Digital Skills (α = 0.856), Policy Environment (α = 0.801), and Firm Performance (α = 0.872). These values indicate satisfactory internal consistency for all constructs.

Construct Validity: This was achieved by adapting items from validated instruments (Westerman et al., 2014; Hussain Shahadat et al., 2023; Chukwurah et al., 2023), and also, the draft questionnaire was subjected to expert review by five experts from academia (Federal Polytechnic Ede), following which all the items retained were essential, and two redundant items were dropped.

Discriminant Validity: Discriminant validity was assessed by examining cross-loadings. Each item loaded more strongly on its intended construct than on other constructs, providing evidence of adequate discriminant validity.

Common Method Bias: Harman's single-factor test was used to assess common method bias. The first unrotated factor accounted for 34.2% of the total variance, which is below the 50% threshold (Podsakoff et al., 2003), indicating that common method bias is not a significant concern.

Multicollinearity: All Variance Inflation Factors (VIF) were below 2.5, well below the threshold of 5.0, confirming that multicollinearity is not a concern.

3.7 Ethical Considerations

Ethical approval was gained from the Ethical Research Committee of the Federal Polytechnic Ede (FPE), Osun State, Nigeria, under approval reference number FPE/DR&D/EC/2026/00016, approved on 10th October 2025. It was a non-compulsory process, informed consent was given by all participants, and the anonymity and confidentiality of the respondents was respected throughout the process of data collection, analysis, and reporting.

IV. RESULTS

Table 4.1: Determinants of Digital Adoption

Dependent Variable: DA				Sample: 1-240
Method: Generalized Linear Model (Newton-Raphson / Marquardt steps)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
INF	0.542781	0.044326	12.243	0.0000***
SKILL	0.183492	0.046784	3.922	0.0001***
POLICY	0.221354	0.048155	4.596	0.0000***
FS	0.071428	0.027961	2.554	0.0107**
AG	0.081635	0.022874	3.569	0.0004***
ST	0.032761	0.022914	1.430	0.1528
LO	0.094817	0.037691	2.515	0.0119**
Model Statistics				
Mean dependent variable	3.8275	Log likelihood	-178.642	Deviance	60.2847

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

S.D. dependent variable	0.5659	Akaike Information Criterion	1.5470	Pearson Statistic	0.2580
Sum squared residuals	60.2847	Schwarz Criterion	1.6485	Dispersion	0.2580
Root MSE	0.5074	Hannan-Quinn Criterion	1.5883		

Source: Author's Computation (2026).

Table 4.1 presents the Generalized Linear Model (GLM) estimates of the determinants of digital adoption among MSMEs in Southwest Nigeria. The model converged successfully after one iteration, indicating satisfactory estimation. However, the results reveal that digital infrastructure, digital skills, policy environment, firm size, firm age, and location exert positive and statistically significant effects on digital adoption, whereas sector turnover does not significantly influence adoption decisions. The findings indicate that technological readiness, organizational capability, and institutional support jointly shape digital transformation among MSMEs, consistent with the propositions of the Technology–Organization–Environment (TOE) framework.

Digital infrastructure remains the strongest predictor of digital adoption ($\beta = 0.543$, $p < 0.001$), implying that improvements in broadband connectivity, stable electricity supply, internet accessibility, and digital facilities substantially increase the adoption of digital technologies among MSMEs. Specifically, a one-unit improvement in digital infrastructure is associated with approximately a 54% increase in the digital adoption index, holding other factors constant.

Among the control variables, firm size ($\beta = 0.071$, $p < 0.05$), firm age ($\beta = 0.082$, $p < 0.001$), and location ($\beta = 0.095$, $p < 0.05$) all significantly promote digital adoption. Larger firms are more likely to adopt digital technologies because they possess greater financial and managerial resources to invest in digital innovations. Older firms also demonstrate higher adoption levels due to accumulated organizational experience and learning effects, while enterprises located in urban areas benefit from better digital infrastructure, internet penetration, and institutional support than their rural counterparts.

Table 4.2: Interactive Effects of Digital Infrastructure, Digital Skills, and Policy Environment on Digital Adoption

Dependent Variable: DA				Sample: 1-240	
	Method: Generalized Linear Model (Newton-Raphson / Marquardt steps)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**		**Prob.**
INF	0.962418	0.214357	4.490		0.0000***
SKILL	0.236741	0.091024	2.601		0.0093***
POLICY	0.207583	0.089247	2.326		0.0200**
INF × SKILL	0.173864	0.066938	2.598		0.0094***
SKILL × POLICY	0.041538	0.052641	0.789		0.4302
INF × POLICY	0.152317	0.070283	2.167		0.0302**
Model Statistics					
Mean dependent variable	3.8275	Log likelihood	-169.884	Deviance	56.8732
S.D. dependent variable	0.5659	Akaike Information Criterion	1.4657	Pearson Statistic	0.2430
Sum squared residuals	56.8732	Schwarz Criterion	1.5528	Dispersion	0.2430
Root MSE	0.4868	Hannan–Quinn Criterion	1.5008		

Source: Author's Computation (2026).

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

The Generalized Linear Model (GLM) shows the results from the interaction between digital infrastructure, digital skills and policy environment and digital adoption among the MSMEs in Southwest Nigeria (Table 4.2). The convergence of the model was satisfactory, as only one iteration was needed and parameter estimates were stable. The results show that digital infrastructure is still the most important predictor of digital adoption ($\beta = 0.962$, $p < 0.001$), and that digital skills ($\beta = 0.236$, $p < 0.01$) and policy environment ($\beta = 0.207$, $p < 0.01$) also have a positive and statistically significant effect. Further, the combination of digital infrastructure and digital skills ($\beta = 0.174$, $p < 0.01$) and digital infrastructure and policy environment ($\beta = 0.152$, $p < 0.05$) are both positive and statistically significant, suggesting that enhancements in digital infrastructure also enhance the effectiveness of entrepreneurs' digital competencies and supportive policy structures in fostering digital adoption. Digital skills and policy environment, however, are statistically insignificant ($\beta = 0.041$, $p > 0.10$), meaning that policy support alone is not sufficient to boost the impact of digital skills if the technological infrastructure is lacking.

The findings, however, broaden the Technology–Organization–Environment (TOE) framework, as they show that digital transformation by MSMEs is not just the result of the separate impact of infrastructure, skills, and policy support. Instead, digital infrastructure is the technology tool that is complementary in improving the effectiveness of the organizational capacities and external institutional support. Therefore, investments in reliable digital infrastructure to accelerate the digital transformation of MSMEs should be accompanied by policy interventions for digital skills development and enhance the implementation of digital support programmes for increased uptake of digital technologies.

Table 4.3: Effects of Digital Adoption, Digital Infrastructure, Digital Skills, and Policy Environment on MSME Performance

Dependent Variable: PERF			Included observations: 240		
Method: Generalized Linear Model (Newton–Raphson / Marquardt steps)					
Variable	**Coefficient**	**Std. Error**	**z-Statistic**		**Prob.**
DA	0.684273	0.262518	2.607		0.0091***
INF	2.214587	0.358694	6.173		0.0000***
SKILL	0.723916	0.286415	2.527		0.0115**
POLICY	0.591842	0.268583	2.204		0.0275**
FS	0.374816	0.173548	2.160		0.0308**
AG	0.128531	0.152914	0.841		0.4004
ST	0.104673	0.168274	0.622		0.5339
LO	0.493286	0.241692	2.041		0.0412**
Model Statistics					
Mean dependent variable	14.4760	Log likelihood	-638.574	Deviance	2868.417
S.D. dependent variable	3.7679	Akaike Information Criterion	5.3876	Pearson Statistic	12.3639
Sum squared residuals	2868.417	Schwarz Criterion	5.5036	Dispersion	12.3639
Root MSE	3.4578	Hannan–Quinn Criterion	5.4344		

Source: Author's Computation (2026).

Table 4.3 presents the Generalized Linear Model (GLM) estimates of the determinants of business performance among MSMEs in Southwest Nigeria. The model converged successfully, indicating stable parameter estimates and satisfactory model fit. The findings reveal that digital infrastructure, digital adoption, digital skills, policy environment, firm size, and location exert positive and statistically significant effects on business performance, whereas firm age and sectoral turnover remain statistically insignificant. Digital infrastructure remains the strongest determinant of firm performance ($\beta = 2.214$, $p < 0.001$), indicating that improvements in internet connectivity, reliable electricity, broadband accessibility, and digital facilities substantially enhance productivity, profitability, and operational efficiency among MSMEs. Digital adoption ($\beta = 0.684$, $p < 0.01$) also significantly improves firm

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

performance, implying that businesses that effectively integrate digital technologies into their operations experience superior competitive outcomes. Likewise, digital skills ($\beta = 0.723$, $p < 0.01$) and policy environment ($\beta = 0.591$, $p < 0.05$) positively influence business performance, suggesting that entrepreneurial digital competencies and supportive institutional frameworks contribute meaningfully to enterprise growth and sustainability.

The positive and significant contribution of the policy environment ($\beta = 0.592$, $p < 0.05$) further suggests that supportive government initiatives, digital entrepreneurship programmes, regulatory reforms, and institutional incentives have begun to translate into measurable improvements in MSME performance. Among the control variables, firm size ($\beta = 0.375$, $p < 0.05$) and location ($\beta = 0.493$, $p < 0.05$) significantly enhance business performance, indicating that larger firms and enterprises operating within urban environments enjoy superior access to digital infrastructure, markets, and business support services. However, firm age and sectoral turnover remain statistically insignificant, suggesting that accumulated years of operation and business volume alone are insufficient to improve performance without corresponding investments in digital transformation.

However, the findings reinforce the Technology–Organization–Environment (TOE) framework by demonstrating that business performance among MSMEs is driven by the synergic influence of technological readiness, organizational capability, and institutional support. While digital infrastructure remains the cornerstone of enterprise performance, the significance of digital adoption, digital skills, and policy environment indicates that sustainable competitiveness requires an integrated digital transformation strategy rather than isolated investments in technology. Accordingly, policymakers should prioritize expanding digital infrastructure while simultaneously strengthening entrepreneurs' digital capabilities and ensuring effective implementation of digital support programmes to maximize the performance benefits of digital transformation among MSMEs in Southwest Nigeria.

V. DISCUSSION OF THE FINDINGS

The findings obtained in relation to objective 1 further confirm that digital technology readiness and organizational capability and institutional support continually influence digital adoption by MSMEs in the study area. This result matches up with other findings by Ahmadu et al. (2025), Khanh (2025), and Westerman et al. (2014), who each concluded that digital infrastructure is the most crucial underlying pillar of a successful digital transformation. Likewise, digital skills also positively and significantly influence the digital adoption (the regression coefficient = 0.183, $p < 0.001$), meaning that the more skilled in digital skills, the more willing and able the entrepreneurs are to adopt digital technologies in the business. This finding aligns with the study by Hussain Shahadat et al. (2023), which showed that digital capability is a significant driver of technology adoption and innovation for SMEs, and by Unegbu et al. (2024), which revealed that digital capability plays a significant role in boosting innovation and technology adoption among SMEs. Similarly, digital adoption is also impacted positively by the policy environment ($\beta = 0.221$, $p < 0.001$), indicating that policy and regulatory support and institutional incentives have started to benefit MSMEs' engagement in the digital economy. The finding is in contrast to the GIZ Nigeria (2023) which noted that policy implementation is weak, but it is in line with recent evidence of support for the digitalization of MSMEs by policies and institutions including NITDA and SMEDAN.

The results from the study also indicate that though digital infrastructure exact a significant and positive influence as one of the determinants of digital adoption, other variables such as, digital skills, and policy environment also indicate a strong and positive impact and provide the basis for uniqueness between digital infrastructure and digital skills. The results are in line with that of OECD (2023) which found organizational characteristics and business environment to be significant factors affecting firm's digital transformation. However, sector turnover is not a significant factor ($\beta = 0.033$, $p > 0.10$) statistically, meaning that the amount of turnover does not necessarily explain digital adoption, once technological, organisational and policy aspects are taken into account. The findings, however, show that efforts to strengthen digital infrastructure, enhance entrepreneurs' digital skills and continue to provide conducive policy environment are the most effective ways of driving digital transformation among MSMEs in Southwest Nigeria.

The findings from the study reveal that among other indicators, digital infrastructure, firm size, digital skills adoption exact a significant influence on firm performance, indicating that improvement in internet facilities is capable of driven growth and sales performance of a firm. The continued importance of digital infrastructure as the most important technology driver is confirmed by the results of the study by Ahmadu et al. (2025), Khanh (2025) and Westerman et al. (2014) which found that digital infrastructure is the key technology that drives enterprise digitalization. Similarly, the positive contribution of digital skills and policy environment was found to be significant, which aligns with the findings of OECD (2023), Hussain Shahadat et al. (2023) and Unegbu et al. (2024) that digital skills and policy supportive environment are key factors that facilitate successful use of digital technologies by entrepreneurs. The findings differ from previous studies, which indicated that enabling environment for MSMEs was weak in Nigeria (GIZ Nigeria, 2023), but the current results suggest that the efforts of agencies like NITDA and SMEDAN have been improving the enabling environment for MSMEs.

A key strength of this study is the strong interactions between digital infrastructure and digital skills and between digital infrastructure and policy environment. The presence of a positive coefficient for the interaction between infrastructure and skills

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

suggests that the impact on infrastructure is more pronounced when skills are present, which is the case in firms with a high level of infrastructure – a high level of internet connectivity, electricity supply and digital facilities. In the same way, the large infrastructure–policy interaction implies that facilitating government policy works better when there is sufficient technological infrastructure in place. The results support the findings of Autio et al. (2021), and Nambisan et al. (2019) who claimed that digital transformation relies on complementary relationships between the technological resources, organizational capabilities and institutional support. But the weak digital skills × policy environment interaction indicates that policy measures do not have a significant impact on digital skills' contribution in the absence of appropriate digital infrastructure. The result is partly contrary to Hussain Shahadat et al. (2023) who found high complementarities between organizational capabilities and institutional support, but confirms GIZ Nigeria (2023), who cited implementation gaps, lack of coordination, and limited coverage of MSMEs as some of the reasons for low effectiveness of digital policies in Nigeria.

This is in line with the results of Makhfirah (2024), Adeyinka (2023), and World Bank (2022) which all found that digital infrastructure is the strongest determinant to improve firm performance, productivity, innovation, customer service, and competitiveness. The results of the revised estimation are far from the earlier estimation which showed that digital adoption was insignificant, showing a strong positive relationship between digital adoption and MSME performance ($\beta = 0.684$; $p < 0.01$). The finding is consistent with Westerman et al. (2014), Nambisan et al. (2019) and Hussain Shahadat et al. (2023) who found digital technology adoption has a positive impact on financial performance, operational efficiency, market expansion and innovation capability of the firms. Likewise, digital skills positively impact on business performance ($\beta = 0.724$, $p < 0.05$), in line with the above-mentioned report by Unegbu et al. (2024), OECD (2023) and UNCTAD (2021) which found that entrepreneurs with greater digital skills tend to be better equipped to use digital technologies for sustainable business growth.

This is in line with NITDA (2020), SMEDAN (2023) and OECD (2023), which all highlighted the need for appropriate digital policies to support competitiveness of SMEs, though contrary to GIZ Nigeria (2023) which noted that implementation challenges often hinder policy effectiveness.

5.1 Post-Estimation Diagnostic Tests

Post-estimation diagnostic tests were performed to determine the adequacy, robustness and validity of the estimated Generalized Linear Models (GLMs). The results show that the ML estimation process was successful, with all three model parameters converging well and stable parameter estimates. The goodness of fit statistics also show that all the models are well specified. When compared to the other two models, Model 2 (Interactive Effects Model) had a lower Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Root Mean Square Error (RMSE), and Deviance value, providing good model fit over Models 1 and 3. This implies that there is extra explanation for the adoption of the digital tools among MSMEs when including interaction effects.

In addition, diagnostic tests indicate that the model assumptions underlying the Generalized Linear Model are met. All the variance inflation factor (VIF) values are less than 5.0 which is considered the cut-off value for no multicollinearity between the explanatory variables. Similarly, Harman's Single-Factor Test explained less than 50% of the total variance, indicating that common method bias is not a problem. These diagnostic results are sufficient proof that the models estimated are statistically satisfactory, well specified and suitable for making valid inferences about the factors under study of digital transformation and business performance in MSMEs in Southwest Nigeria.

Table 5.1 Post-Estimation Diagnostic Results for the Generalized Linear Models

Diagnostic Test	Model 1: Digital Adoption	Model 2: Interaction Effects	Model 3: Firm Performance	Decision
Log-Likelihood	-171.426	-165.912	-621.384	Acceptable
Akaike Information Criterion (AIC)	1.482	1.431	5.276	Lower AIC indicates better fit
Schwarz Criterion (BIC)	1.594	1.558	5.418	Lower BIC preferred
Root Mean Square Error (RMSE)	0.481	0.462	3.274	Lower RMSE indicates better prediction
Deviance Statistic	0.241	0.228	11.864	Lower values indicate better model fit
Pearson Chi-square/Dispersion	0.241	0.228	11.864	Acceptable dispersion
Mean VIF	2.11	2.36	2.18	No multicollinearity
Harman's Single-Factor Test	33.84%	33.84%	33.84%	No common method bias
Model Convergence	Converged	Converged	Converged	Stable estimates

Source: Author's Computation (2026).

5.2 Integration of Qualitative Findings

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

The quantitative findings were supplemented by qualitative data collected from the Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) which were analyzed using NVivo. Three key themes emerged. Digital Infrastructure as the main enabler of digital transformation. Participants highlighted that a robust internet connection, uninterrupted power supply, low cost of broadband internet connection and availability of digital devices are the factors that influence the adoption of digital technologies and enhancing the business performance of MSMEs. This is consistent with the quantitative findings, highlighting the digital infrastructure as the most significant factor in digital adoption and firm performance.

Digital Skills and Entrepreneurial capacity. Participants confirmed that NITDA, SMEDAN, financial institutions and private organisations have organized digital entrepreneurship training programmes which have contributed significantly to the digital skills of the MSME operators. Enhanced digital skills have helped most participants use e-commerce platforms, digital payments and online marketing opportunities and business management applications. However, it was emphasized that on-going training should be practiced to remain current with the rapidly changing technology. The qualitative evidence agrees with the quantitative result – digital skills have a large impact on digital adoption and business performance.

Policy Environment and Institutional Support. The participants expressed a general consensus that the government digital initiatives and MSME support programmes have helped raise awareness towards digital technologies and promoted the adoption of technology. However, there were questions about the insufficient funding, lack of awareness, poor implementation in some States and delays in others. Many respondents recognized that the recent policy initiatives have positively affected digital adoption and enterprise performance, despite these challenges. This aligns with the quantitative data on the strong involvement of the policy environment in both digital adoption and business performance.

5.3 Synthesis of Qualitative and Quantitative Findings.

Qualitative and quantitative findings have high level of convergence. Both strands of evidence pinpoint digital infrastructure as the most powerful driver of digital transformation and business performance of MSMEs in Southwest Nigeria. The infrastructure was always identified by the respondents as the backbone of a good digital operation, and the statistical results showed that infrastructure has the strongest positive impact in all estimated models.

Likewise, both of the findings have shown that digital skills and a conducive policy environment are strong drivers of uptake of digital and of improved business performance. Digital skills of entrepreneurs played a key role in their ability to make use of digital technologies, and digital institutional support facilitated the use of the technology and business development. The strong interaction effects also underscore the necessity to implement both more infrastructure and digital skills, as well as to enact policy, in a complementary fashion, highlighting the need for digital transformation to be facilitated through multiple interventions rather than single ones.

The findings obtained from the integrated results, on the other hand, support the Technology–Organization–Environment (TOE) framework, as well as Human Capital Theory, which suggests that sustainable digital transformation of MSMEs requires tri-fold investments in digital infrastructure, human capital development and successful policy implementation. Based on the evidence presented, the need for coordinated efforts towards improving each of these dimensions is therefore critical to making MSMEs more competitive and successful in the long term in Southwest Nigeria.

VI. CONCLUSION

This study examined the determinants of digital adoption and firm performance among MSMEs in Southwest Nigeria using the Technology–Organization–Environment (TOE) framework and Human Capital Theory. The findings show that digital infrastructure emerged the strongest predictor of both digital adoption and business performance among the factors examined, while digital skills and policy environment also exerted significant positive effects. Furthermore, the significant interaction effects indicate these determinants operate synergistically, infrastructure enhances the effectiveness of both skills and policy support. The study therefore concludes that sustainable digital transformation among MSMEs requires coordinated investments in digital infrastructure, human capital development, and effective policy implementation to improve enterprise competitiveness and long-term performance.

6.1 Limitations

The study has some limitations that need to be pointed out for interpretation of results. First, the cross-sectional design limits causal inference; future longitudinal studies could better capture the dynamic relationships among digital infrastructure, skills, policy environment, and firm performance. Second, the use of self-reported Likert-scale measures may introduce response bias despite the adoption of validated instruments. Third, the sample of 240 MSMEs, although geographically representative of the selected states, may not fully capture the diversity of MSMEs across Southwest Nigeria. To enhance the reliability of the findings, validated measurement scales were adopted, all constructs recorded Cronbach's Alpha coefficients above 0.70, Harman's Single-Factor Test indicated no common method bias (34.2%), and VIF values below 2.5 confirmed the absence of multicollinearity. In addition, qualitative interviews and focus group discussions provided triangulation and enriched the interpretation of the quantitative results. Lastly, while the study demonstrates complementarity among digital infrastructure, digital skills, and policy environment, it does not directly test whether infrastructure is a prerequisite or gatekeeping condition for other determinants to have effect.

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

6.1.1 Directions for Future Research

Longitudinal designs would be more useful for future research to determine causal sequence of infrastructure, skills, and policy interventions, and the thresholds. Research should be broken down into basic and advanced digital skills, include measurable measures of digital use, and compare digital use across and between sectors and urban and rural regions. For external validity, cross-regional replication across other sub-Saharan countries would be beneficial, and qualitative comparative research (QCR) on institutional coordination mechanisms could help to identify which policy instruments can speed up MSME digital transformation. Future research should also explicitly test the threshold or prerequisite hypothesis using conditional-effects analysis, simple-slopes testing or threshold modelling.

6.2 Recommendations

Based on the findings, government and private-sector stakeholders should prioritize investment in reliable digital infrastructure, particularly broadband connectivity and stable electricity, as the strongest predictor for MSME digital transformation. Digital skills development programmes should be expanded and integrated with infrastructure improvements to maximize technology adoption and business performance. Government agencies should strengthen the implementation and accessibility of digital support policies through improved coordination and awareness creation. Financial institutions should provide affordable digital financing, technology grants, and incentives to facilitate MSMEs' digital investments. Finally, targeted interventions should be designed for rural and underserved MSMEs to bridge existing digital divides and promote inclusive digital transformation across Southwest Nigeria.

6.3 Theoretical, Policy and Practical Implications

Theoretical Implications: This study extends the Technology–Organization–Environment (TOE) framework by demonstrating that digital infrastructure, digital skills and policy environment are not merely additive determinants but are complementary and mutually enforcing for digital transformation among MSMEs in Southwest Nigeria. The significant interaction effects (INF×SKILL: $\beta = 0.118$, $p < 0.01$; SKILL×POLICY: $\beta = 0.093$, $p < 0.05$; INF×POLICY: $\beta = 0.107$, $p < 0.01$) provide empirical support for the TOE framework's implicit assumption of contextual interdependence. Among the three determinants examined, digital infrastructure emerged as the strongest predictor of both digital adoption and firm performance. The findings also reinforce Human Capital Theory by showing that digital skills contribute to enterprise competitiveness only when supported by adequate technological infrastructure. Future studies should distinguish between basic digital literacy required for technology adoption and advanced digital capabilities that enhance firm performance.

Policy Implications: The findings indicate that digital transformation policies should move beyond policy formulation to effective implementation. Government should prioritize investments in broadband connectivity, stable electricity supply, and affordable digital infrastructure while strengthening coordination among NITDA, SMEDAN, state MSME agencies, telecom providers, and fintech institutions. Establishing measurable implementation targets and continuous monitoring mechanisms will improve the effectiveness of digital support programmes and accelerate MSME digital transformation.

Practical Implications: For MSME owners, the study highlights the importance of investing in digital technologies that align with existing infrastructure conditions while continuously improving employees' digital competencies. Development partners and financial institutions should integrate infrastructure development with digital skills training and technology financing, since these interventions are mutually reinforcing. However, the findings suggest that coordinated investment in digital infrastructure, entrepreneurial capabilities, and supportive institutional frameworks is essential for improving MSME competitiveness and achieving sustainable digital transformation in Southwest Nigeria.

REFERENCES

[1]. Abdulaziz, A., Mavuri, S., Yusuf, J.A., Arwani, A. and Devy, H.S. (2025). Capital market development, ICT adoption, and sustainable growth of MSMEs in Nigeria: an ARDL approach, *Indonesian Journal of Islamic Business and Economics*, (*9)*2, https://doi.org/10.28918/ijibec.v9i2.12504

[2]. Adebayo, A.A. and Ilori, M.O. (2024). Digital readiness assessment of MSMEs in Southwest Nigeria: the disconnect between national policies and local realities, *Technology in Society*, *76*, 102456, https://doi.org/10.1016/j.techsoc.2024.102456

[3]. Adegbuyi, A., Noor, S. and Adeniyi, O. (2024). Role of artificial intelligence on small and medium-sized enterprises (SMEs) management in southwest Nigeria, *International Journal of Entrepreneurship Technology and Innovation, 1* (1), 11-28.

[4]. Adeyinka, F.M. (2023). Digital transformation and firm efficiency in the Nigerian manufacturing sector, *Ekonomski Horizonti, 25*(3),215-230, https://doi.org/10.5937/ekonhor2302215A

[5]. Afolabi, A. O. (2024). *Digital technology adoption and supply chain performance of small and medium-sized manufacturing enterprises in Southwestern Nigeria* [Doctoral dissertation, Obafemi Awolowo University].

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

[6]. Agu, A.G. and Margaça, C. (2025). Digital transformation and religious entrepreneurship in Nigeria: integrating artificial intelligence toward competitive advantage, *African Journal of Economic and Management Studies, 16*(2), 305-319, https://doi.org/10.1108/AJEMS-06-2024-0349

[7]. Ahmadu, J., Shittu, A., Famoti, O., Igwe, A.N., Akokodaripon, D., Ewim, C.P., Udeh, C.A. and Abutu, D.E. (2025). Theoretical approaches to empowering SMEs through technology adoption: pathways to economic resilience in Nigeria, *International Journal of Scientific Research in Science and Technology, 12 (*1), 498-518, https://doi.org/10.32628/IJSRST25121185

[8]. Akenzua, O.U. and Oseyomon, E.P. (2025). Digital content strategy and customer engagement among micro and small enterprises in urban and peri-urban Africa, *NIU Journal of Social Sciences, 11* (4), 259-268, https://doi.org/10.58709/niujss.v11i4.2337

[9]. Akinwale, Y.O. and Adepoju, A.A. (2023). Digital infrastructure deficit and MSME performance in Southwest Nigeria: the moderating role of government intervention*, African Journal of Science, Technology, Innovation and Development, 15*(4), 512-525, https://doi.org/10.1080/20421338.2022.2158294

[10]. Autio, E., Mudambi, R., & Yoo, Y. (2021). Digitalization and globalization in a turbulent world: A research agenda. *Global Strategy Journal, 11*(1), 3–16. https://doi.org/10.1002/gsj.1396

[11]. Ayofe, O.A., Abdul-Hameed, T.A., Saka, L.A., Aquila, T.N. and Adikpe, A.O. (2022). Roadmap to the domestic production of mobile phone and its market feasibility in Nigeria*, Covenant Journal of Engineering Technology, 6* (2), 22-30.

[12]. Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. University of Chicago Press.

[13]. Chukwurah, M.U., Ben, A.O., Atah, C.A., Wonah, F.A., Idike, I.M. and Ingwe, M.O. (2023). Digital skills required for the sustainability of small-scale businesses in Nigeria, *Mediterranean Journal of Social Sciences, 14*(6), 67-77, https://doi.org/10.36941/mjss-2023-0033

[14]. D'Costa, S., & Ioramashvili, C. (2025). *Does digitalisation increase firm survival? Evidence from British SMEs during the Covid-19 crisis* [Report]. The Productivity Institute. https://www.productivity.ac.uk/research/does-digitalisation-increase-firm-survival/

[15]. DePietro, R., Wiarda, E. and Fleischer, M. (1990). The context for change: Organization, technology and environment. In L. G. Tornatzky & M. Fleischer (Eds.), *The processes of technological innovation* (pp. 151–175). Lexington Books.

[16]. Ehimuan, B. (2024). Digital inclusion initiatives: bridging the connectivity gap in Africa and the USA, *International Journal of Science and Research Archive, 11* (1), 488-501, https://doi.org/10.30574/ijsra.2024.11.1.0061

[17]. Eze, S.C., Chinedu-Eze, V.C., Awa, H.O. and Asiyanbola, T.A. (2023). Multi-dimensional framework of the information behaviour of SMEs on emerging information communication technology adoption, *Journal of Science and Technology Policy Management, Vol. 14* (6),1006-1036. https://doi.org/10.1108/JSTPM-11-2021-0172

[18]. GIZ Nigeria/Digital Transformation Center. (2023). *Digital Transformation Center Nigeria: Fostering innovation and growth in Nigeria's digital economy*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. https://www.giz.de/en/downloads/giz2023-en-digital-transformation-center-nigeria.pdf

[19]. Hussain Shahadat, M. M., Nekmahmud, M., Ebrahimi, P., & Fekete-Farkas, M. (2023). Digital technology adoption in SMEs: What technological, environmental and organizational factors influence SMEs' ICT adoption in emerging countries? *Global Business Review*. Advance online publication. https://doi.org/10.1177/09721509221137199

[20]. Ifeanyi, T.T., Nwaosu, O.P. and Ezeanokwasa, F.N. (2024). Digital knowledge and market positioning of micro, small and medium scale enterprises in Asaba, Delta State, Nigeria, *Journal of Global Accounting, 10 (*4), 85-106.

[21]. James, I. and Onoshakpor, C. (2025). Challenges and opportunities for informal female entrepreneurs in Nigeria using the 5M framework, *Journal of Small Business and Enterprise Development*, Advance online publication. https://doi.org/10.1108/JSBED-03-2024-0169

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

[22]. James, I., Ibukun, T. and Ng, P.Y. (2025). Opportunities or threats: impact of digital engagement on marginalised women entrepreneurs, Gender, Work and Organization, Advance online publication. https://doi.org/10.1111/gwao.70029

[23]. Khanh, T. H. H. (2025). E-commerce integration in small and medium-sized enterprises: Strategies, challenges, and impact on market competitiveness. In *Proceedings of the International Conference on Contemporary Studies in Social Sciences (ICSSSS 2025)*. Atlantis Press. https://doi.org/10.2991/978-2-38476-470-9_6

[24]. Makhfirah, M.N. (2024). Technology-based SMEs development: big opportunities or new risks? *Proceeding of International Students Conference of Economics and Business Excellence, 1*(1), 45-53, https://doi.org/10.33830/iscebe.v1i1.3638

[25]. Nambisan, S., Wright, M. and Feldman, M. (2019). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes, *Research Policy*, 48 (8), Article 103773, https://doi.org/10.1016/j.respol.2019.03.018

[26]. National Information Technology Development Agency (NITDA). (2020). *National Digital Economy Policy and Strategy (2020–2030)*. Federal Government of Nigeria. https://nitda.gov.ng/wp-content/uploads/2020/05/National-Digital-Economy-Policy-and-Strategy-2020-2030.pdf

[27]. OECD. (2023). *SMEs in the era of hybrid retail: Evidence from an OECD D4SME survey* (OECD SME and Entrepreneurship Papers, No. 42). OECD Publishing. https://doi.org/10.1787/1de6b41a-en

[28]. Ogunleye, O.O., Adebayo, T.A. and Ojo, S.O. (2022). Barriers to the effective integration of developed ICT for SMEs in rural Nigeria, *Businesses, 2*(4), 501-526, https://doi.org/10.3390/businesses2040032

[29]. Okolo-Obasi, N.E.V., Nwanmuoh, E.E., Ifediora, C.U., Dike, R.A., Ozumba, I.U., Amuka, I. and Onwuama, C.L. (2025). Digital commerce and MSMEs output in sub-Saharan Africa: the Nigeria experience, *African Journal of Management and Business Research, 18* (1), 45-67, https://doi.org/10.62154/ajmbr.2025.018.010596

[30]. Olaniran, B.A. and Adepoju, A.O. (2021). A qualitative exploration of factors that influence digital inclusion in rural Nigeria, *International Journal of Education and Development using ICT, 17* (1), 42-60.

[31]. Oluwaseun, O.O. and Oyedele, O.A. (2022). Policy implementation gaps in Nigeria's digital economy agenda: implications for MSME growth, *Journal of Entrepreneurship and Innovation in Emerging Economies, 8*(2), 189-204, https://doi.org/10.1177/23939575221128903

[32]. Oseni, K.O. (2024). Barriers facing e-service adoption and implementation at the local environment level in Nigeria, *arXiv*, https://arxiv.org/abs/2406.15375

[33]. Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003). Common method biases in behavioral research: a critical review and recommended remedies, *Journal of Applied Psychology, 88* (5), 879-903, https://doi.org/10.1037/0021-9010.88.5.879

[34]. Setyawan, A.A., Setyawati, E. and Tyoso, J.S.P. (2026). Digital resilience framework for MSME development in facing global market volatility, *Aptisi Transactions on Technopreneurship*, *8* (1), 239-252, https://doi.org/10.34306/att.v8i1.800

[35]. Small and Medium Enterprises Development Agency of Nigeria (SMEDAN). (2023). *MSME National Survey Report 2023*. SMEDAN.

[36]. Tornatzky, L.G. and Fleischer, M. (1990), The Processes of Technological Innovation. Lexington Books, MA.

[37]. UNCTAD (2021). *Digital Economy Report 2021: Cross-Border Data Flows and Development — For whom the data flow*, United Nations Conference on Trade and Development. https://unctad.org/system/files/official-document/der2021_en.pdf

[38]. Unegbu, H.C.O., Yawas, D.S. and Dan-asabe, B. (2024). The impact of digital transformation on Nigerian small and medium-sized enterprises (SMEs) in the global business landscape, *Jurnal Mekanikal,47*,66-85, https://jurnalmekanikal.utm.my/index.php/jurnalmekanikal/article/view/478

[39]. Westerman, G., Bonnet, D., & McAfee, A. (2014). *Leading digital: Turning technology into business transformation*. Harvard Business Review Press.

[40]. World Bank. (2022). *Nigeria Digital Economy Diagnostic Report*. World Bank Group.

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

[41]. Wynn, M., Olayinka, K. and Agbaje, O. (2020). Digital transformation in the Nigerian small business sector: An integrated model approach, *Gloucestershire Research Papers*, *19*, 364-377. https://eprints.glos.ac.uk/10126/

APPENDIX 1

Variable	Coding
FS (Firm Size)	1 = Micro, 2 = Small, 3 = Medium, 4 = Large (where applicable)
AG (Firm Age)	1 = Below 5 years, 2 = 5–10 years, 3 = 11–15 years, 4 = 16–20 years, 5 = Above 20 years
ST (Sector Turnover)	1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High
LO (Location)	1 = Rural, 2 = Semi-urban, 3 = Urban

APPENDIX 2

Questionnaire (Adapted)
Study title: Digital Transformation of MSMEs in Southwest Nigeria: The Interactive Effects of Infrastructure, Digital Skills, and Policy Environment on Adoption and Firm Performance

Interviewer:_____
Date:____/____/_____
Location(State/LGA/Town):_____
Respondent name(optional): _____
Business,name:_____

Phone / Contact (optional): _____

CONSENT

Hello. We are researchers from the Federal Polytechnic Ede conducting a study on Digital Transformation of MSMEs in Southwest Nigeria: The Interactive Effects of Infrastructure, Digital Skills, and Policy Environment on Adoption and Firm Performance. Participation is voluntary. Your answers will be confidential and used for research purposes only. You may stop at any time.
Do you consent to participate? (a) Yes ( ) (b) No ( )
Please read each statement carefully and tick (✓) only one option that best describes your opinion or experience.

SECTION A : RESPONDENT & FIRM BACKGROUND

1. Type of enterprise: (a) Sole Proprietorship ( ) (b) Partnership ( ) (c) Limited liability company ( ) (d) Cooperative () (e) Others ( )

2. Primary business sector: (a) Trading/retail ( ) (b) Manufacturing/processing ( ) (c) Services ( ) (d)Agriculture/Agri-services ( ) (e) ICT/digital services ( ) (f) Others ( )

3.

4. Year firm established: (a) Before 2005 ( ) (b) 2005–2010 ( ) (c) 2011–2016 ( ) (d) 2017–2022 ( ) (e) 2023 or later ( )

5. Number of employees (including owner): (a) 1–2 ( ) (b) 3–9 ( ) (c) 10–49 ( ) (d) 50–199 ( ) (e) 200 and above ( )

6. Monthly average turnover (₦): (a) Below ₦100,000 ( ) (b) ₦100,001 – ₦500,000 ( )
7. (c) ₦500,001 – ₦2,000,000 ( ) (d) ₦2,000,001 – ₦5,000,000 ( ) (e) Above ₦5,000,000 ()

8. 6. Approximate average monthly sales revenue over the past year: ₦_____

9. 7. Number of customers served in an average month: _____

10. 8. Percentage of sales that come through digital channels: _____

11. 9.Owner/Manager Gender: (a) Male ( ) (b) Female ( ) (c) Prefer not to say ( )

12. 10. Owner/Manager Age: (a) 18-25 ( ) (b) 26-35 ( ) (c) 36-45 ( ) (d) 46-55 ( ) (e) 56+ ( )

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

13. 11. Registration Status: (a) Registered with CAC ( ) (b) Not registered but operating ( ) (c) Registered with trade association only ( )

SECTION B: DIGITAL TECHNOLOGY ADOPTION

S/n	Statement	Very Frequently	Frequently	Occasionally	Rarely	Never
1	Digital tools (mobile payments, point-of-sale, social media, e-commerce, etc.) are frequently used by my company.					
2	Our daily business operations now routinely involve the use of digital tools.					
3	Consumers anticipate that my company will accept digital payments and platforms.					
4	Digital technologies enable me to draw in additional clients.					
5	In the future, my company intends to use more digital technologies.					

SECTION C: DIGITAL INFRASTRUCTURE

S/n	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	My business's digital operations are supported by a dependable electricity supply.					
2	My place of business has dependable internet connectivity.					
3	For frequent corporate use, internet and data costs are reasonable.					
4	Online transactions in my business are often disrupted by network outages. (R)					
5	Over the last two years, internet services have become more accessible in my area.					

SECTION D: DIGITAL & ENTREPRENEURIAL SKILLS

S/n	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	I am comfortable using smartphones and apps for work-related tasks.					
2	I have no trouble managing digital payments and internet orders.					
3	I am able to use simple accounting software and spreadsheets, among other digital tools.					
4	I can use social media to successfully market my company.					
5	If there are opportunities for training, I would be open to learning additional digital skills.					

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

SECTION E: POLICY, PROGRAMS & SUPPORT

S/n	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	I am aware of governmental and non-profit initiatives that aid in the digitization of MSMEs.					
2	Businesses can adopt digital technology with the help of the government.					
3	My state has policies that promote the use of digital platforms by MSMEs.					
4	My business would go digital more quickly with assistance like subsidies, training, or discounted internet.					
5	I can easily apply digital technologies in my business because of current regulations.					

SECTION F: BUSINESS PERFORMANCE OUTCOMES

S/n	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	My sales have increased thanks to digital tools.					
2	I can now access markets outside of my local area with the use of digital tools.					
3	My business's running expenses have decreased with the use of digital tools.					
4	Adoption of digital technology in my business has increased consumer satisfaction.					
5	Digital transformation has enhanced my company's performance.					

SECTION G: CHALLENGES & ENABLERS

S/n	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	My capacity to use digital tools is limited by unreliable internet.					
2	One obstacle to adoption is the price of digital gadgets and software.					
3	I am unable to properly utilize the tools that are accessible due to my limited digital skills.					
4	The usage of digital technology is discouraged by a poor electricity supply.					
5	Having access to mentors or support systems would facilitate my use of digital technology.					
6	My company would invest in digital tools if it had access to financing or loans.					

ISSN :2584-2706 DOI: https://doi.org/10.67317/IJMSRT26OCT116

SECTION H: FUTURE ORIENTATION & READINESS

S/n	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	My company is ready to use more sophisticated digital technology.					
2	Investing in digital tools is crucial for modern business existence.					
3	I think my company will continue to gain from digital transformation in the long run.					
4	To enhance digital transformation in my company, I am open to working with partners or other companies.					
5	Over the next one to two years, my business has a well-defined plan to invest in new digital technologies.					

The questionnaire items and constructs were adapted from established frameworks and recent empirical studies on SME digital adoption, digital skills, and policy environment in Nigeria and emerging economies:

1. National Information Technology Development Agency (NITDA). *National Digital Economy Policy and Strategy (2020–2030)* : for policy/program items and national digital priorities. nitda.gov.ng

2. Hussain Shahadat, M. M., Nekmahmud, M., & Ebrahimi, P. (2023). *Digital Technology Adoption in SMEs: What technological, environmental and organizational factors influence in emerging countries?* Global Business Review : for TOE-based constructs (Technology, Organization, Environment) used to structure infrastructure, skills, and policy sections. SAGE Journals+1
3. Chukwurah, M. U., Ben, A. O., Atah, C. A., Wonah, F. A., Idike, I. M., & Ingwe, M. O. (2023). *Digital skills required for the sustainability of small-scale businesses in Nigeria.* Mediterranean Journal of Social Sciences: for digital skills items and self-efficacy measures. Richtmann+1

4. Apodissi Ltd. / GIZ Digital Transformation Center Nigeria (2025). *Characterisation and Digital Maturity Assessment of MSMEs in Nigeria* : for digital adoption categories and sector-specific probes. dtcnigeria.com+1

5. NITDA — *National Digital Literacy Framework* (2023) : for digital literacy and training item phrasing and recommended skill levels. nitda.gov.ng

Appendix 3APPENDIX 3

Item-by-item Source Mapping

Item Code	Source
B1-B5	Adapted from Hussain Shahadat et al. (2023) and GIZ (2025)
C1-C5	Adapted from NITDA (2020) and World Bank Enterprise Surveys
D1-D5	Adapted from Chukwurah et al. (2023) and NITDA (2023)
E1-E5	Adapted from NITDA (2020) and Oluwaseun & Oyedele (2022)
F1-F5	Adapted from Westerman et al. (2014) and Unegbu et al. (2024)