emerald PUBLISHING

Strategy & Leac

DIGITAL MATURITY AND HYBRID STRATEGIES IN EMERGING MARKETS: THE STRUCTURAL LIMITS OF ENTREPRENEURIAL TRANSFORMATION

Journal:	*Strategy & Leadership*
Manuscript ID	SL-09-2025-0284
Manuscript Type:	Research Paper
Keywords:	Technology–Organisation–Environment (TOE) Framework, Digital Maturity, Hybrid Business Models, Digital Entrepreneurship, Institutional Voids, Emerging Markets

DIGITAL MATURITY AND HYBRID STRATEGIES IN EMERGING MARKETS: THE STRUCTURAL LIMITS OF ENTREPRENEURIAL TRANSFORMATION

ABSTRACT

Purpose

This study examined the influence of digital maturity, technological adoption, and environmental barriers on entrepreneurial performance within Nigeria's diverse business landscape. By situating the Technology–Organisation–Environment (TOE) framework within conditions of institutional voids, the paper challenges assumptions of linear digital transformation and explores hybridity as an adaptive organisational equilibrium.

Design/methodology/approach

A cross-sectional survey of 553 entrepreneurs across Nigeria's six geopolitical zones was analysed using ANOVA, chi-square tests, and robustness diagnostics. The analysis examined the effects of digital maturity, digital tool adoption, and systemic barriers on revenue generation, customer acquisition, operational efficiency, and market expansion, while controlling for sectoral and locational differences to account for contextual heterogeneity.

Findings

Results demonstrate that advanced digital maturity and broad tool adoption significantly enhance performance outcomes, while infrastructural deficits, policy inconsistency, and skill gaps act as structural determinants that constrain digital integration. Hybrid business models emerge as a pragmatic equilibrium in navigating institutional voids, especially in high-potential sectors such as fintech, edutech, agritech, and healthtech. The findings reveal that maturity trajectories are nonlinear and often threshold-based, with effects stronger in urban regions, reflecting entrenched structural inequalities.

Originality/value

This study advances digital entrepreneurship theory by reframing the TOE model through a structural lens, showing that environmental constraints are not passive conditions but active determinants of digital trajectories. It introduces hybridity as a theoretically significant equilibrium form in emerging markets and reconceptualises digital maturity as nonlinear, contingent, and threshold-based rather than sequential and linear.

Practical/policy implications

This research highlights the urgency of addressing infrastructural, policy, and skills barriers to unlock the full potential of digital entrepreneurship. Policy interventions should prioritise reliable infrastructure, coherent regulation, and advanced capacity building, while managers should pursue hybrid strategies to balance ambition with contextual realities.

Keywords

Digital Entrepreneurship; Digital Maturity; Hybrid Business Models; Technology–Organisation–Environment (TOE) Framework; Institutional Voids; Emerging Markets.

1. INTRODUCTION

The accelerated diffusion of digital technologies has become one of the most significant forces shaping contemporary business environments (Ly, Chen, & Sharma, 2023, Journal of Business Venturing). From cloud computing and data analytics to mobile platforms and artificial intelligence, digital integration is widely heralded as a key driver of firm productivity, innovation, and competitiveness (Nambisan, Zahra, & Luo, 2022). Yet, despite this consensus, empirical outcomes remain strikingly uneven. While firms in advanced economies often report performance improvements following digital adoption (Chen, Hu, & Tan, 2024, Strategic Management Journal), many organisations in emerging markets struggle to translate integration into measurable gains (Olanrewaju, Sarpong, & Newenham-Kahindi, 2023). This paradox raises critical questions about the contingencies under which digital maturity produces superior entrepreneurial performance. In contexts marked by institutional voids, infrastructural deficits, and fragile entrepreneurial ecosystems, digital transformation cannot be assumed to yield uniform results (Khanna & Palepu, 2023). Instead, it presents a complex and theoretically underexplored challenge that calls for deeper examination (Autio, Nambisan, & Zahra, 2023).

The importance of resolving this challenge extends well beyond practice. Scholars in strategy, information systems, and entrepreneurship increasingly recognise that digital integration is not merely a technical upgrade but a dynamic capability requiring organisational orchestration and contextual adaptation (Warner & Wäger, 2022). Yet existing theorisation has been largely derived from developed economies, where institutional infrastructures support seamless adoption and scaling (Berente, Lyytinen, Yoo, & Maurer, 2023). In such environments, digital maturity is often theorised as a linear trajectory: firms progress through sequential stages of adoption, each delivering incremental performance improvements (Sebastian, Ross, & Beath, 2022). However, this linearity assumption overlooks conditions where infrastructural weaknesses, regulatory uncertainty, and market fragmentation disrupt the expected trajectory (George, Kotha, & Parikh, 2022). Nowhere is this tension more visible than in Africa's largest economy, Nigeria, where digital adoption has accelerated but outcomes for entrepreneurial performance remain inconsistent (Nwankpa, Ifinedo, & Boateng, 2023). Nigeria thus presents not only an important empirical setting but also a critical theoretical context in which to challenge prevailing assumptions about the digital–performance nexus (Akpan, Essien, & Ismail, 2022).

Three complications sharpen the theoretical stakes in this study. First, although digital integration is presumed to enhance firm outcomes, Nigerian evidence reveals inconsistent performance trajectories: some firms achieve efficiency gains and expanded market access, while others encounter rising costs and operational setbacks (Okpara & Adeniran, 2022). Secondly, institutional voids and infrastructural gaps amplify these inconsistencies. Weak broadband penetration, unreliable electricity supply, and uneven digital policy enforcement result in divergent outcomes from identical technologies, depending on locational and sectoral contingencies (Khanna & Palepu, 2023). Thirdly, and most importantly, digital maturity itself may be nonlinear in emerging markets. Rather than a steady, stage-wise progression, maturity may involve reversals, plateaus, or leapfrogging effects, producing contingent rather than linear performance impacts (Zeng, Griffith, & Zahra, 2024). These complications unsettle the theoretical consensus that digital integration straightforwardly improves entrepreneurial outcomes, inviting a reconsideration of the underlying mechanisms (Sandberg & Alvesson, 2021).

Despite mounting evidence of these contradictions, existing literature has yet to adequately theorise the interplay of digital integration, institutional voids, and entrepreneurial performance. Research in information systems often emphasises adoption drivers, including technological readiness, organisational resources, and environmental pressures as captured in the Technology–Organisation–Environment (TOE) framework (Baker, 2012; Tornatzky & Fleischer, 1990). While valuable, TOE treats institutional context largely as an environmental backdrop, underemphasizing how voids actively shape adoption trajectories (Ly, Chen, & Sharma, 2023). Similarly, strategy research has invoked dynamic capabilities to explain how

firms orchestrate resources in the digital age (Warner & Wäger, 2022). Yet this stream rarely considers how infrastructural deficits or informal governance regimes condition the effectiveness of such capabilities (George et al., 2022). Entrepreneurship studies, meanwhile, highlight how digitalisation enables opportunity recognition and scaling (Autio, Nambisan, & Zahra, 2023, Entrepreneurship Theory & Practice) but often assume enabling ecosystems rather than void-filled contexts (Nwankpa et al., 2023). These blind spots collectively limit our understanding of how digital integration unfolds in fragile institutional environments (Cornelissen, Hällgren, & Rouleau, 2024).

We therefore ask: Under what conditions does digital integration enhance, constrain, or produce nonlinear effects on entrepreneurial performance in emerging markets? This question is not only practically urgent but theoretically generative. By situating digital maturity within institutional voids, we move beyond the assumption of linear and universally positive outcomes to consider contingencies that moderate or even reverse expected effects (Rouse, Corley, & Gioia, 2025). Nigeria provides an ideal setting for theorising this puzzle. As Africa's largest economy and one of the continent's most digitally active entrepreneurial ecosystems, Nigeria combines rapid technological diffusion with persistent infrastructural and institutional deficits (Akpan et al., 2022). These features make it a natural laboratory for examining how digital integration interacts with voids to shape entrepreneurial outcomes (George et al., 2022).

This study makes three contributions. First, we advance digital integration theory by embedding it within the institutional voids' perspective, thereby explaining why performance outcomes vary under fragile infrastructures (Khanna & Palepu, 2023). In doing so, we challenge the linear consensus in extant models and demonstrate how maturity can be contingent and nonlinear (Zeng et al., 2024). This extension contributes to ongoing debate about theorising complications, puzzles, and paradoxes as engines of conceptual progress (Sandberg & Alvesson, 2021; Rouse et al., 2025). Secondly, we extend the theorisation of digital transformation to African entrepreneurial ecosystems, which remain underrepresented in leading journals despite their richness for theory development (George et al., 2022). By theorising Nigeria's entrepreneurial ecosystem as a boundary condition, we generate insights generalizable to other emerging economies facing similar voids (Autio et al., 2023). Thirdly, we develop transparent and replicable measures of digital maturity that account for nonlinear trajectories, addressing calls for methodological rigour in studying digital transformation (Berente et al., 2023, MIS Quarterly). These measures enable future scholars to compare integration pathways across diverse contexts and contribute to the accumulation of cumulative knowledge (Cornelissen et al., 2024).

2. LITERATURE REVIEW

The diffusion of digital technologies has been widely theorised as a catalyst for entrepreneurial growth and competitiveness, with studies consistently linking adoption to improved productivity, efficiency, and innovation (Nambisan, Zahra, & Luo, 2022). Yet, despite the broad consensus, empirical findings across emerging markets reveal strikingly uneven and often contradictory outcomes. While some entrepreneurs report efficiency gains and market expansion through digital adoption, others encounter rising operational costs, skill gaps, and stagnation in performance (Autio, Nambisan, & Zahra, 2023). This inconsistency presents a theoretical conundrum: under what conditions does digital adoption lead to superior entrepreneurial outcomes, and under what conditions does it fail to do so?

Mainstream theorisation often treats digital integration as a linear progression, where firms advance through sequential stages of adoption and maturity, each delivering incremental performance improvements (Sebastian, Ross, & Beath, 2022). Such models, however, largely originate from developed economies with stable infrastructures and enabling institutions. In fragile institutional environments such as Nigeria, characterised by infrastructural deficits, regulatory volatility, and market fragmentation, digital adoption trajectories appear nonlinear, contingent, and hybridised (George, Kotha, & Parikh, 2022). Nigeria thus represents not only an important empirical setting but also a critical theoretical context for revisiting assumptions about the digital–performance nexus.

The Technology–Organisation–Environment (TOE) framework (Tornatzky & Fleischer, 1990) provides a robust foundation for theorising digital entrepreneurship under such conditions. TOE posits that technology adoption is shaped by three interrelated dimensions: technological capabilities, organisational attributes, and environmental context. While prior research has validated TOE across multiple settings, its application often assumes that the "environment" constitutes a relatively stable backdrop rather than an active, constraining force (Baker, 2012). In Nigeria, however, institutional voids (Khanna & Palepu, 2023) and infrastructural gaps transform the environment into a structural determinant of adoption pathways, compelling entrepreneurs to recalibrate technological and organisational strategies.

This study, therefore, extends TOE theory by embedding it within the realities of institutional voids and dynamic capability constraints. From a technological perspective, Nigerian entrepreneurs operate in a dual-speed ecosystem: basic digital tools, such as mobile payments and social media, enjoy near-universal adoption, while advanced technologies, including AI, blockchain, and CRM systems, remain underutilised due to cost and skill barriers (Oyedele & Oyero, 2022). Organisationally, firms respond to these conditions by experimenting with hybrid business models that blend physical and digital operations, allowing them to mitigate infrastructural uncertainty while exploiting digital efficiencies (Okoye, 2025). Environmentally, regulatory inconsistencies and infrastructural deficits create nonlinear maturity paths where adoption may stall, reverse, or leapfrog stages, in contrast to linear models derived from developed economies (Zeng, Griffith, & Zahra, 2024).

Against this backdrop, our theorisation unfolds around two interrelated puzzles. First, how do entrepreneurs navigate Nigeria's volatile infrastructure to identify viable digital opportunities? Evidence suggests that hybrid models, combining physical operations with digital platforms, are not transitional strategies but rather adaptive equilibria tailored to fragile ecosystems. Unlike fully digital models that presuppose reliable infrastructures, hybrids allow entrepreneurs to participate in digitally intensive sectors (fintech, edutech, agritech, healthtech) while retaining physical touchpoints that buffer against infrastructural shocks. This perspective challenges assumptions in developed economy research that digital entrepreneurship inevitably trends toward full dematerialisation (Clark & Mayer, 2016). Instead, it suggests that hybridity represents a strategic recalibration within TOE's organisational and environmental dimensions, enabling firms to sustain viability under uncertainty.

Hypothesis 1 (H1): Entrepreneurs adopting hybrid business models are more likely to pursue opportunities in high-potential digital sectors (fintech, edutech, agritech, healthtech) than those opting for fully digital operations.

Secondly, even where entrepreneurs embrace digital tools, the relationship between adoption and performance is not uniform. While the adoption of social media, mobile payments, and e-commerce platforms tends to yield efficiency gains and expanded market access, the underutilisation of advanced technologies reflects a dual-speed adoption economy. Firms with limited resources often plateau at intermediate levels of adoption, unable to unlock the transformative potential of AI-driven analytics or cloud-based systems. This complicates TOE's technological dimension by demonstrating that adoption is not a binary (adopt vs. not adopt), but a stratified process in which the depth and sophistication of adoption critically shape outcomes. Empirical evidence from Nigerian SMEs indicates that the breadth of adoption (number of tools) and the depth of adoption (sophistication of tools) have divergent impacts on revenue, efficiency, and competitiveness (Otoo et al., 2023; Chen & Liu, 2023).

Hypothesis 2 (H2): Higher levels of digital tool adoption among Nigerian entrepreneurs are positively associated with improved business performance outcomes.

If tool adoption represents the first layer of entrepreneurial digitalisation, digital maturity captures the degree to which technologies are embedded into firms' strategy, culture, and operations (Felicetti, Corvello, & Ammirato, 2023). Unlike adoption, which emphasises access and uptake, maturity reflects integration:

the capacity to orchestrate tools into coherent, value-generating systems. Firms at advanced maturity levels typically exhibit agility, data-driven decision-making, and process automation, enabling them to respond to market turbulence with greater resilience (Warner & Wäger, 2022). Yet, in emerging economies such as Nigeria, maturity trajectories often diverge from the linear progression assumed in mainstream TOE applications. Evidence suggests that firms may plateau at intermediate levels or "leapfrog" stages by selectively integrating advanced tools while neglecting foundational infrastructures (Zeng, Griffith, & Zahra, 2024). Moreover, infrastructural volatility means that regressions are possible: digital operations may be rolled back when electricity shortages or connectivity failures render them unsustainable (Sunday, Umeifekwem, & Eme, 2023). Thus, digital maturity in fragile contexts should not be conceptualised as a smooth trajectory but as a nonlinear, contingent process, shaped by structural voids and adaptive organisational strategies.

Advanced maturity nonetheless delivers disproportionate benefits. Firms that successfully embed digital systems report superior outcomes across revenue growth, customer acquisition, operational efficiency, and market expansion (Niankara, 2024). This suggests that the returns to maturity are convex: marginal gains at beginner or intermediate stages are modest, while advanced maturity yields transformative performance differentials. TOE's technological and organisational dimensions thus need to be reinterpreted as cumulative and threshold-based, where strategic advantages emerge only once maturity surpasses a critical integration threshold.

Hypothesis 3 (H3): Higher levels of digital maturity among Nigerian entrepreneurs are positively associated with improved business performance outcomes.

While maturity promises performance gains, the barriers constraining digital integration remain formidable. Infrastructure remains the most pervasive constraint: Nigeria's chronic electricity shortages and uneven broadband access undermine the stability of digital platforms and discourage investment in advanced technologies (Aina, Aime, & Lazar, 2022). These environmental realities demonstrate that TOE's "environment" is not merely an external backdrop but an active determinant shaping adoption pathways. Secondly, high implementation costs impose prohibitive thresholds, particularly for SMEs. The acquisition of hardware, licenses, and technical expertise often outweighs short-term performance returns, forcing firms into partial or superficial adoption (Nkwo & Eneiga, 2024). This creates a dual-speed economy in which larger firms with deeper pockets advance toward maturity while smaller ones stagnate, widening performance disparities. Thirdly, skills deficits persist. Although Nigeria's entrepreneurial class is relatively young and educated, gaps in advanced digital capabilities prevent the effective deployment of sophisticated tools such as AI and cloud systems (Irele, 2021). As TOE's organisational dimension predicts, absorptive capacity is a decisive mediator between adoption potential and realised benefits (Drummond, McGrath, & O'Toole, 2018). Finally, policy inconsistency compounds uncertainty. Frequent regulatory shifts, delays in implementation, and bureaucratic inefficiencies create a climate of unpredictability that undermines entrepreneurs' confidence in digital investment (Suleiman, Daura, & Liberty, 2023). In fragile contexts, such institutional volatility acts as a structural constraint, recalibrating how entrepreneurs configure their technological and organisational strategies (Khanna & Palepu, 2023). These barriers constrain digital integration, not by eliminating adoption, but by truncating maturity trajectories, resulting in uneven, dual-speed digitalisation.

Hypothesis 4 (H4): Barriers to digital integration (infrastructure deficits, high costs, skill gaps, policy inconsistency) negatively affect digital adoption and maturity levels among Nigerian entrepreneurs.

By reframing TOE within the realities of Nigeria's entrepreneurial ecosystem, this study advances theory in three ways (Table 1). First, it introduces nonlinearity and hybridity as central features of digital entrepreneurship under institutional voids, challenging the implicit linearity of maturity models. Second, it demonstrates that TOE's environmental dimension must be reconceptualised not as a backdrop but as a structural determinant actively shaping adoption trajectories. Third, by integrating sectoral opportunities,

barriers, and maturity thresholds, the study develops a more contingent and context-sensitive TOE model that explains both the promise and the limits of digital transformation in emerging markets.

[INSERT TABLE 1 HERE]

2.6 Conceptual Framework

The relationship between digital entrepreneurship and firm performance in emerging markets cannot be theorised adequately without recognising the dynamic interplay of technological capabilities, organisational configurations, and environmental constraints. Building on the Technology–Organisation–Environment (TOE) framework (Tornatzky & Fleischer, 1990), this study develops a conceptual framework that extends TOE to account for nonlinearity, hybridity, and institutional voids as defining features of digital transformation in fragile ecosystems. Rather than treating the environment as a passive backdrop, this framework positions environmental barriers as active structural determinants that truncate adoption trajectories, while organisational hybridity and digital maturity serve as adaptive mechanisms that mediate performance outcomes.

Digital maturity is posited as a central determinant of entrepreneurial outcomes. In advanced economies, digital maturity is frequently conceptualised as a linear progression, where each stage of adoption yields incremental efficiency gains (Sebastian, Ross, & Beath, 2022). However, evidence from emerging markets suggests that maturity is better understood as a nonlinear and contingent process (Zeng, Griffith, & Zahra, 2024). Firms may plateau at intermediate stages due to skill gaps or infrastructural deficits, regress when environmental volatility undermines systems, or leapfrog stages by adopting advanced solutions selectively (George, Kotha, & Parikh, 2022). This reconceptualisation directly extends TOE's technological dimension by recognising maturity not as a uniform outcome but as a threshold-based enabler: significant performance advantages accrue primarily when firms achieve advanced, integrated maturity (Warner & Wäger, 2022). Accordingly, H3 posits that higher levels of digital maturity are positively associated with business performance outcomes, including revenue growth, customer acquisition, operational efficiency, and market expansion.

TOE's environmental dimension often treats external conditions as contextual moderators. Yet, in fragile institutional environments such as Nigeria, barriers are not peripheral but structural determinants of entrepreneurial outcomes. Chronic electricity shortages have limited broadband access, and inconsistent regulatory frameworks have actively shaped adoption trajectories, constraining firms' capacity to achieve advanced maturity (Aina, Aime, & Lazar, 2022; Sunday, Umeifekwem, & Eme, 2023). Moreover, high implementation costs disproportionately disadvantage SMEs, entrenching a dual-speed digital economy where only well-capitalised firms advance toward maturity (Nkwo & Eneiga, 2024). Skills deficits exacerbate these dynamics, with many firms lacking the absorptive capacity to deploy and leverage advanced systems (Drummond, McGrath, & O'Toole, 2018). These barriers exert a truncating force, reducing the depth of adoption and slowing the progression of maturity. This yields H4, which asserts that environmental barriers, encompassing infrastructural, financial, skills-related, and policy domains, negatively impact the adoption and maturity levels of Nigerian entrepreneurs.

Organisational responses to these environmental constraints frequently manifest as hybrid business models, which blend physical and digital operations. In contrast to studies in developed economies that depict full digitalisation as the apex of entrepreneurial transformation, hybrids emerge in Nigeria as adaptive equilibria. They allow entrepreneurs to participate in digitally intensive sectors (fintech, edutech, agritech, healthtech) while maintaining physical touchpoints that buffer against infrastructural volatility (Okoye, 2025). This perspective extends TOE's organisational dimension by positioning hybridity not as a transitional stage but as a strategic recalibration in response to systemic fragility. On this basis, H1 proposes that entrepreneurs adopting hybrid models are more likely to pursue opportunities in high-potential digital sectors than those opting for fully digital operations.

Finally, the framework incorporates the adoption of digital tools as a mediating mechanism between technological readiness and performance. Adoption breadth (the range of tools) and depth (the sophistication of tools) produce divergent effects: while basic tools such as mobile payments and social media yield incremental gains, advanced systems such as AI and cloud computing enable transformative outcomes but remain underutilised due to barriers (Oyedele & Oyero, 2022; Chen & Liu, 2023). This dual-speed adoption economy underscores the need to theorise adoption as a stratified process, extending TOE's technological domain to distinguish between rudimentary and advanced capabilities. Accordingly, H2 posits that the higher the adoption of digital tools, the more positively it is associated with improved entrepreneurial performance.

The conceptual framework in this study (Figure 1) theorises digital entrepreneurship in Nigeria as a product of recursive interactions among technological capabilities, organisational strategies, and environmental constraints. These extensions not only generate testable hypotheses but also address the theoretical question of why digital adoption in emerging markets yields heterogeneous outcomes. By integrating TOE with insights from institutional voids (Khanna & Palepu, 2023), dynamic capabilities (Warner & Wäger, 2022), and entrepreneurship theory (Autio, Nambisan, & Zahra, 2023), this study provides a contingent, context-sensitive model of digital entrepreneurship suited to the realities of fragile institutional environments.

[INSERT FIGURE 1 HERE]

2. METHODOLOGY

3.1 Research Design and Rationale

This study employs a quantitative, cross-sectional survey design to examine the relationships between digital maturity, barriers to adoption, and entrepreneurial performance outcomes in Nigeria. The choice of design is anchored in the Technology–Organisation–Environment (TOE) framework (Tornatzky & Fleischer, 1990), which conceptualises adoption as shaped by technological capabilities, organisational attributes, and environmental conditions. Cross-sectional survey methods allow the simultaneous capture of perceptual and behavioural data across these three dimensions, offering an integrative lens to test the TOE framework in an emerging-market setting. The use of surveys is particularly appropriate in contexts where institutional voids and infrastructural deficits limit the availability of archival data (Khanna & Palepu, 2023). By relying on entrepreneurs' self-reported assessments of digital adoption and performance outcomes, surveys provide access to granular insights that would otherwise be unavailable in Nigeria's fragmented data environment (George, Kotha, & Parikh, 2022).

While cross-sectional designs cannot establish strict causality, they remain suitable for theorising in volatile environments where longitudinal stability is limited (Autio, Nambisan, & Zahra, 2023). To mitigate the risk of spurious associations, the study incorporates multiple design features: (i) Explicit measurement of the sequence of digital adoption relative to performance outcomes, thereby strengthening causal inference. (ii) Inclusion of control variables (sector, firm size, firm age, and location), which TOE theory identifies as critical environmental and organisational attributes. (iii) Adoption of multi-method analytical strategies (ANOVA, regression, and structural equation modelling) to triangulate results across complementary statistical approaches. This triangulation reflects recent methodological debates in management research that emphasise robustness through multiple analytical lenses (Cornelissen, Hällgren, & Rouleau, 2024).

3.2 Sample and Sampling Strategy

To capture the heterogeneity of Nigeria's entrepreneurial ecosystem, we employed a stratified random sampling technique. Nigeria's six geopolitical zones served as strata, ensuring representation of regional diversity in infrastructure, institutional support, and entrepreneurial density, factors consistent with TOE's

environmental dimension. Stratified sampling is theoretically aligned with TOE's assertion that adoption trajectories vary with environmental heterogeneity (Warner & Wäger, 2022).

The target population comprised entrepreneurs and senior decision-makers (owners, executives, and professionals) in micro, small, and medium enterprises across sectors. This focus ensures respondents possess sufficient managerial discretion to influence technology adoption, consistent with TOE's organisational dimension (Drummond, McGrath, & O'Toole, 2018). The final sample included 553 respondents, which exceeds the minimum thresholds for both regression and structural equation modelling. Following Cohen's (1992) power analysis guidelines, the sample size provides sufficient power (>0.95) to detect small to medium effect sizes ($f2 = 0.02$) at conventional significance levels ($\alpha = 0.05$). This statistical justification is critical for ensuring that non-significant results reflect substantive rather than sampling limitations.

Sectors were purposively weighted toward fintech, edutech, agritech, and healthtech, which embody Nigeria's most salient opportunities for digital transformation. Fintech's role in advancing financial inclusion (Otuya, Alonge, & Oluwafemi, 2024), edutech's contribution to educational access (Clark & Mayer, 2016), agritech's potential for food security (Nura, 2022), and healthtech's promise for healthcare delivery (Tidjani & Madour, 2024) collectively represent the technological frontier of Nigeria's entrepreneurial ecosystem.

3.4 Data Collection Procedures

Data were collected through a structured online questionnaire administered via Google Forms and distributed across professional networks, entrepreneurial hubs, and sectoral associations. Online distribution was justified by its capacity to reach geographically dispersed respondents at relatively low cost, a critical advantage in resource-constrained environments (Chen & Liu, 2023). Recognising the digital divide in Nigeria, particularly between urban and rural regions, we complemented online distribution with targeted outreach through local business associations in areas with lower connectivity. This hybrid strategy aligns with TOE's organisational dimension by tailoring collection methods to contextual constraints.

The instrument was developed through a multi-stage process:

i. Initial items were adapted from validated scales in prior TOE-based research.

ii. A panel of five experts in digital entrepreneurship reviewed the items for content validity.

iii. A pilot test with 20 entrepreneurs from fintech, agritech, and edutech sectors was conducted to assess clarity, reliability, and completion time. Feedback-informed refinements to wording and scale anchors.

The final questionnaire included sections on: (i) demographics, (ii) firm characteristics, (iii) digital adoption practices, (iv) barriers to digital integration, and (v) business performance outcomes.

3.5 Measures and Variables

3.5.1 Digital Maturity

Digital maturity was operationalised as the extent to which digital technologies are embedded in business processes. Following Felicetti, Corvello, & Ammirato (2023), respondents categorised their firms as: Beginner, predominantly manual operations; Intermediate, partial digitisation of processes; and Advanced, full automation and data-driven decision-making. This categorical operationalisation is consistent with our nonlinear theorisation of maturity, which posits threshold effects rather than incremental gains (Zeng, Griffith, & Zahra, 2024).

3.5.2 Business Performance Outcomes

Performance was measured across four indicators: revenue growth, customer acquisition, operational efficiency, and market expansion. Each was assessed using five-point Likert scales, capturing perceived improvements attributable to digital integration. This aligns with TOE's technological domain, where adoption outcomes manifest in financial and market performance (Niankara, 2024).

3.5.3 Barriers to Digital Integration

Barriers were measured across four dimensions: infrastructure, costs, skills, and policy, based on prior research in emerging markets (Aina, Aime, & Lazar, 2022). Respondents rated the severity of each barrier on a five-point Likert scale. These constructs align with TOE's environmental dimension, conceptualised here as structural determinants of adoption (Sunday, Umeifekwem, & Eme, 2023).

3.5.4 Control Variables

To reduce omitted variable bias, we controlled firm size, firm age, sector, and geographic location, consistent with TOE's recognition that organisational and environmental attributes moderate adoption outcomes (George, Kotha, & Parikh, 2022).

3.6 Analytical Techniques

A multi-method analytical strategy was adopted to test the framework.

(a) ANOVA

First, a one-way Analysis of Variance (ANOVA) was used to test differences in business performance across digital maturity levels. This is appropriate since maturity is measured categorically. The model specification is:

$$Y_{ij} = \mu + \tau_i + \epsilon_{ij}$$

Where Y_{ij} is the performance score for firm j in maturity group i, μ is the grand mean, τ_i represents the effect of maturity level, and ϵ_{ij} is the error term.

(b) Regression Analysis

To examine continuous relationships and robustness, we estimated multiple regression models:

$$\text{Performance}_i = \beta_0 + \beta_1 \text{Maturity}_i + \beta_2 \text{Adoption}_i + \beta_3 \text{Barriers}_i + \beta_4 \text{Controls}_i + \epsilon_i$$

This specification allows simultaneous estimation of the effects of maturity, adoption, and barriers, while adjusting for sector, size, and location.

(c) Structural Equation Modelling (SEM)

Finally, **Partial Least Squares Structural Equation Modelling (PLS-SEM)** was employed to model latent constructs (maturity, barriers, adoption) and test their interrelationships in accordance with TOE's multidimensional structure. The SEM specification is:

$$\eta = B_\eta + \Gamma\xi + \zeta$$

Where η represents endogenous latent variables (performance), ξ exogenous constructs (maturity, barriers, adoption), B is the matrix of relationships among endogenous variables, Γ captures paths from exogenous to endogenous constructs, and ζ is the error term. Bootstrapping (5,000 resamples) was used to derive confidence intervals for path coefficients, ensuring robustness under non-normality.

Bias and endogeneity were addressed through several strategies. Respondents were asked to indicate whether performance changes occurred after adoption, thereby strengthening causal inference through

temporal sequencing. To assess common method variance, both Harman's single-factor test and a marker variable approach were employed, with results indicating that no single factor accounted for more than 30% of the variance. Endogeneity concerns were mitigated through robustness checks, including instrumental variable regressions that employed sectoral digital infrastructure as instruments. Finally, multicollinearity diagnostics indicated that all Variance Inflation Factors (VIF) were below 2.0, suggesting negligible risk of collinearity.

4. RESULT AND ANALYSIS

4.1 Assumptions, Robustness, and Contextual Stability

We first verified that our mean-comparison and regression models meet the usual regularity conditions and, where appropriate, paired classical estimators with robust alternatives. Shapiro–Wilk tests indicated mild, isolated deviations from normality; because the groups are balanced and reasonably large, the F-test is strong to such departures. Levene's tests showed no evidence of variance heterogeneity for any outcome (revenue generation, customer acquisition, operational efficiency, market expansion; all $p > .09$), and Welch's ANOVAs, robust to heteroscedasticity and non-normality, remained highly significant across all outcomes (all $p < .001$; Tables 2).

To mitigate omitted-variable concerns, we estimated ANCOVAs including sector and firm size. The main effects of digital maturity and digital tool adoption remained large and strongly significant (e.g., F=112.08 for revenue; F=95.10 for customers; F=92.54 for efficiency; F=48.17 for market expansion; all $p < .001$; Table A/R3). Collinearity diagnostics were benign (maximum VIF=1.45 in bivariate models; all VIFs <2.0 in covariate-augmented models; Tables A).

Contextual stability was assessed via urban–rural splits. Effects were directionally consistent and significant in both subsamples, with larger magnitudes in urban areas (e.g., revenue F = 124.31 for urban vs. 65.27 for rural; all $p < .001$), consistent with the stronger infrastructural and institutional scaffolding in cities anticipated by the environmental arm of TOE (Table 2).

We probed for potential common-method variance using Harman's single-factor test and a marker-variable test; in neither case did a single factor account for more than 30% of the variance. Instrumented regressions using sectoral digital-infrastructure exposure as an instrument yielded positive and significant main effects that mirrored the ANOVA/ANCOVA inferences (Table A). Collectively, these diagnostics indicate that our results are not artefacts of distributional assumptions, unequal variances, multicollinearity, CMV, or modest endogeneity.

[INSERT TABLE 2 HERE]

4.2 Demographics, Business Characteristics, and Adoption Patterns

The respondent pool skews young (45.6% aged 26–35) and highly educated (79.8% with tertiary degrees), suggesting substantial organisational human capital for digital uptake. Geographically, 44.3% of firms are located in the Southwest, with <14% from the Northeast/Northwest, reflecting the well-documented environmental asymmetries in infrastructure and market access. Entrepreneurs/business owners constitute 45.6% of respondents; services account for 41.8% of firms; and 73.4% operate in urban centres.

Adoption patterns reveal a two-speed digital economy, characterised by near-universal use of social media (94.9%) and high uptake of mobile payments (74.7%), alongside comparatively limited penetration of advanced tools, including AI/ML (32.9%) and cloud computing (27.8%). Motivations are predominantly

strategic, with market expansion (87.2%) and process optimisation (83.5%) being the primary drivers, rather than purely reactive. Digital **maturity** clusters at intermediate levels (62.0%), with 27.8% at the beginner level and only 10.1% at the advanced level, a distribution consistent with threshold dynamics in integration (Table 3).

[INSERT TABLE 3 HERE]

4.3 Hypothesis Tests

A chi-square test of independence confirms a strong association between business model (hybrid vs fully digital) and sectoral participation (χ^2 (3) = 45.31, p<.001; Table 4). Multinomial logit models corroborate that hybrid organising predicts engagement in fintech, edtech, and agritech. Inference: *H1 supported.* In TOE terms, hybrid models combine organisational routines and physical touchpoints to buffer environmental frictions, enabling entry into digitally intensive sectors despite infrastructural volatility.

One-way ANOVA revealed that higher adoption levels are associated with significantly better outcomes in terms of revenue, customer acquisition, operational efficiency, and market expansion (all F > 46, p < .001; Table 4). OLS regressions return positive and significant coefficients across all outcomes. Thus, *H2 is supported.* Adoption translates into performance when technological assets are embedded within organisational routines, as TOE's T×O complementarity implies.

ANOVA revealed significant differences across maturity tiers for all outcomes (all F > 52, p < .001; Table 4). Pairwise contrasts indicate Advanced > Intermediate > Beginner. The regression results are consistent with a convex pattern; returns rise sharply once the integration thresholds are crossed. Inference: *H3 supported.* This is consistent with maturity as embedded, routinised integration rather than mere tool presence.

Perceived barriers (infrastructure, costs, skills, policy inconsistency) are negatively associated with integration (ANOVA F=82.47, p<.001; confirmatory regressions show β<0; Table 4). Inference: *H4 supported.* Barriers operate as structural environmental constraints, limiting the depth of adoption and delaying transitions to higher maturity.

[INSERT TABLE 4 HERE]

4.4 PLS-SEM Pathway Model

We estimated a PLS-SEM to capture the TOE-consistent sequencing maturity → adoption → performance, moderated by barriers. All indicator loadings exceeded 0.70; composite reliability was greater than 0.80; AVEs were >.50. Bootstrapped paths (5,000 resamples) were significant: Maturity → Adoption: β = 0.41; p<.001, Adoption → Performance: β = 0.37, p<.001, Barriers → Adoption: β = –0.29; p<.001, Maturity × Barriers → Adoption: β = –.15; p=.007. Explained variance was substantive (R^2_Adoption = 0.46; R^2_Performance = 0.52; Table 5). The structural pattern clarifies that maturity enhances the *capacity* to adopt, adoption improves *realised* outcomes, and barriers depress both levels and payoffs by raising environmental thresholds. The negative interaction indicates that environmental frictions partially erode the translational effect of maturity on adoption, precisely the mechanism TOE attributes to the E context.

[INSERT TABLE 5 HERE]

These findings are internally consistent across assumption checks, robustness to specification, contextual splits, and a structural model that mirrors the theorised TOE sequence. These results converge on three theoretical insights. First, digital adoption and maturity each exhibit reliable, economically meaningful associations with performance across revenue, customers, efficiency, and market reach. The stronger gains at higher maturity tiers and the convex patterning indicate threshold effects: once interoperable

architectures, data governance, and automation routines are in place, returns accelerate. Secondly, hybrid organising emerges as a context-appropriate equilibrium rather than a transitory compromise. By combining physical and digital channels, entrepreneurs counteract infrastructural unreliability and institutional volatility while still leveraging the scale benefits of platforms, which is why they are overrepresented in fintech, edtech, and agritech. Thirdly, barriers behave as structural determinants, not background noise. Infrastructure unreliability, high technology costs, skill gaps, and policy inconsistency hinder adoption intensity, slow progression along the maturity curve, and widen urban–rural disparities, resulting in a dual-speed digital economy.

This empirical evidence supports all four hypotheses and advances a TOE-anchored account in which (i) maturity and adoption are distinct but complementary levers, (ii) hybrid business models adapt organisational design to environmental constraints, and (iii) barriers shape both the feasibility and payoff of digital investment. The convergence of classical, robust, covariate-adjusted, IV-augmented, and PLS-SEM evidence strengthens confidence in the stability of these inferences across specifications and contexts.

5. DISCUSSION OF FINDINGS

This study examined the impact of digital maturity, digital tool adoption, and environmental barriers on entrepreneurial outcomes in Nigeria, offering new insights into the dynamics of digital transformation in emerging economies. While the empirical results broadly support the Technology–Organisation–Environment (TOE) framework (Tornatzky & Fleischer, 1990), they also compel significant theoretical refinements. By integrating TOE with perspectives from institutional voids, dynamic capabilities, and entrepreneurship-as-practice, the findings contribute to a more context-sensitive and contingent theory of digital entrepreneurship in fragile institutional environments.

The evidence that entrepreneurs favouring hybrid business models disproportionately pursue high-potential digital sectors such as fintech, edutech, and agritech ($\chi^2 = 45.31$, $p < .001$) demonstrates that hybridity is not a transitional compromise but a stable equilibrium. This extends TOE's organisational dimension, showing that strategy is recalibrated in response to environmental volatility. Whereas research in developed economies often valorises fully digital models as the apex of innovation (Clark & Mayer, 2016; Sebastian et al., 2022), Nigerian entrepreneurs balance digital channels with physical infrastructures to mitigate connectivity unreliability, institutional weakness, and consumer trust deficits. This interpretation is enriched by entrepreneurship-as-practice theory, which conceptualises entrepreneurship as adaptive improvisation within systemic constraints (Thompson et al., 2020). Hybridity here is theorised as a deliberate strategic adaptation, suggesting that in contexts of infrastructural fragility, organisational models evolve into hybrid equilibria rather than linear stages of digitalisation.

Findings on digital tool adoption further advance TOE's technological and organisational domains. ANOVA and regression results confirmed that higher adoption levels significantly improve performance outcomes across revenue ($F = 59.34$, $p < .001$), customer acquisition ($F = 54.71$, $p < .001$), operational efficiency ($F = 49.16$, $p < .001$), and market expansion ($F = 46.89$, $p < .001$). Yet, adoption patterns reveal a dual-speed digital economy: the ubiquitous uptake of low-cost tools, such as social media (94.9%) and mobile payments (74.7%), contrasts with limited penetration of advanced technologies, including AI (32.9%) and cloud computing (27.8%). This bifurcation underscores that adoption breadth is not equivalent to adoption depth. Through the lens of dynamic capabilities theory, breadth reflects entrepreneurs' ability to seize immediate efficiencies, while depth requires the higher-order capabilities of learning, integration, and reconfiguration (Teece, 2021). The underutilisation of advanced tools highlights a capability trap: firms can achieve short-term efficiency gains but risk plateauing if they fail to develop absorptive capacities for transformative digitalisation. This extends TOE by linking adoption trajectories to capability-building processes rather than treating adoption as a binary event.

The relationship between digital maturity and performance emerged as the most decisive result. ANOVA tests showed significant differences across maturity levels for all indicators, revenue ($F = 115.80$, $p < .001$), customer acquisition ($F = 98.62$, $p < .001$), operational efficiency ($F = 98.55$, $p < .001$), and market expansion ($F = 52.21$, $p < .001$), with advanced firms reporting mean revenue scores nearly double those of beginner firms. Regression models confirmed that advanced maturity delivered the strongest performance coefficients. These results validate prior claims that digital maturity reflects a holistic organisational transformation encompassing strategic agility, cultural embedding, and data-driven decision-making (Felicetti et al., 2023). Yet, our findings extend this perspective by demonstrating that maturity is nonlinear and threshold-based, rather than incremental. Firms stagnate at intermediate levels when infrastructural and financial constraints prevent further integration, while those that cross maturity thresholds enjoy convex returns. This aligns with recent theorising that dynamic capabilities yield disproportionate performance effects once resource reconfigurations reach critical mass (Zeng et al., 2024). TOE's technological dimension thus requires reconceptualisation: maturity should be theorised not as a linear continuum but as a threshold construct.

The role of environmental barriers provides perhaps the most consequential theoretical extension. ANOVA results confirmed that infrastructural deficits, high costs, skill shortages, and policy inconsistencies significantly suppress digital integration ($F = 82.47$, $p < .001$; $F = 69.12$, $p < .001$), and regression models revealed strong negative coefficients for all barrier categories. These findings substantiate TOE's environmental dimension but also push it further. Barriers are not mere contextual moderators; they are structural determinants that truncate adoption and maturity trajectories. This insight aligns with institutional voids theory, which emphasises how infrastructural gaps and regulatory weaknesses actively shape entrepreneurial behaviour (Khanna & Palepu, 2023). Our evidence shows that even technologically ambitious firms are structurally constrained when the environmental foundations are weak. By quantifying these effects, the study reframes the environmental dimension of TOE as an active, deterministic force, thereby advancing the theory toward a structural TOE model of digital entrepreneurship.

Integrating these findings generates a richer theoretical narrative. Hybridity and maturity emerge as mediating mechanisms through which environmental constraints shape technological adoption and performance. In developed contexts, TOE is often applied under assumptions of infrastructural adequacy and institutional reliability, where adoption is limited only by organisational readiness. In Nigeria, however, the findings indicate that the structural limitations of the environment influence adoption decisions. Hybridity becomes a rational equilibrium strategy, adoption breadth without depth reflects capability traps, and maturity functions as a nonlinear threshold process. Together, these dynamics position TOE not as a universalist framework but as a contingent theory of digital entrepreneurship in institutional voids.

This theorisation also has implications for policy and practice. If barriers are structural determinants, then interventions in infrastructure, cost structures, and skills are not auxiliary supports but core levers for digital transformation. The finding that 72.4% of respondents reported performance improvements following adoption underscores that entrepreneurial agency is present but structurally constrained. Policies that provide reliable electricity, affordable cloud infrastructure, and advanced digital training can directly shift firms from intermediate to advanced maturity, enabling them to cross the threshold into convex performance gains. In this sense, policy should be conceptualised not as an external context but as an integral component of the TOE environment, actively shaping the trajectory of entrepreneurial outcomes.

Theoretically, this study contributes three key refinements to TOE (Table 6). First, it reconceptualises maturity as nonlinear and threshold-based, capturing convex returns once integration crosses critical thresholds. Second, it positions hybridity as a stable organisational equilibrium, not a transitional

compromise. Third, it reframes environmental barriers as structural determinants rather than contextual moderators. By embedding these refinements in the TOE framework and integrating them with institutional voids, dynamic capabilities, and entrepreneurship-as-practice, the study develops a contingent theory of digital entrepreneurship that is better suited to emerging economies. This contribution advances scholarship by demonstrating that digital transformation is equally about navigating structural limitations as it is about leveraging technological opportunities.

6. CONCLUSION AND IMPLICATIONS

This study investigated the impact of digital maturity, digital tool adoption, and environmental barriers on entrepreneurial performance in Nigeria. The empirical findings strongly support the Technology–Organisation–Environment (TOE) framework but also necessitate theoretical refinement. By integrating TOE with insights from institutional voids, dynamic capabilities, and entrepreneurship-as-practice, we provide a contingent account of digital entrepreneurship in fragile institutional contexts. The study contributes to theory, practice, and policy by revealing three interlocking dynamics: the nonlinearity of maturity–performance relationships, the stability of hybridity as an organisational equilibrium, and the structural determinism of environmental barriers.

Empirically, our analyses revealed that entrepreneurs relying on hybrid business models are disproportionately represented in high-potential digital sectors such as fintech, edutech, and agritech ($\chi^2 = 45.31$, $p < .001$). Tool adoption was significantly associated with higher performance across revenue ($F = 59.34$, $p < .001$), customers ($F = 54.71$, $p < .001$), efficiency ($F = 49.16$, $p < .001$), and market expansion ($F = 46.89$, $p < .001$), yet adoption patterns reflected a dual-speed ecosystem: ubiquitous uptake of low-cost tools but limited penetration of advanced technologies. Firms with advanced digital maturity outperformed all others on every indicator (e.g., $F = 115.80$, $p < .001$ for revenue), demonstrating convex returns once maturity thresholds were crossed. Environmental barriers exerted strong negative effects ($F = 82.47$, $p < .001$; $F = 69.12$, $p < .001$), confirming their role as structural constraints. These results collectively demonstrate that digital entrepreneurship in Nigeria is dynamic yet uneven, shaped as much by systemic limitations as by entrepreneurial agency.

Theoretically, our study makes three primary contributions. First, we extend TOE by reconceptualising digital maturity as a nonlinear, threshold-based phenomenon that delivers convex returns once integration crosses critical levels. Prior applications of TOE have often assumed linear relationships between adoption and performance; our results challenge this assumption by demonstrating that intermediate maturity yields modest benefits, whereas advanced maturity drives exponential outcomes (Zeng et al., 2024). Second, we reposition hybridity as a stable equilibrium rather than a transitional stage. While studies of developed economies frequently valorise fully digital models (Clark & Mayer, 2016; Sebastian et al., 2022), our findings show that in environments marked by infrastructural volatility, hybrid configurations represent deliberate strategies that balance efficiency with resilience (Thompson et al., 2020). This advances TOE's organisational dimension by introducing hybridity as a mediating mechanism between environmental adversity and technological ambition. Third, we reframe environmental barriers as structural determinants rather than contextual moderators. By quantifying their magnitude and showing how they truncate even technologically ambitious firms, our study aligns TOE with institutional voids theory (Khanna & Palepu, 2023) and positions barriers as central explanatory forces in digital entrepreneurship. Collectively, these contributions advance TOE from a general adoption model toward a contingent theory of digital entrepreneurship in the context of institutional voids.

Practically, the findings underscore that policy interventions are not auxiliary but foundational. Infrastructure, cost reductions, and advanced digital skills are not contextual supports but core levers of transformation. Our evidence, which shows that 72.4% of entrepreneurs reported performance improvements after adoption, confirms that entrepreneurial agency exists but is structurally constrained.

Investments in reliable electricity, affordable access to cloud infrastructure, and advanced training can directly shift firms from intermediate to advanced maturity, unlocking nonlinear performance benefits. For entrepreneurs, the results highlight that reliance on basic tools may yield short-term efficiencies but risks entrenching firms in low-performance equilibria without deeper integration.

Despite these contributions, this study also surfaces opportunities for further theorisation and methodological refinement. First, future research should examine hybridity as an equilibrium across other institutional voids. Is hybridity a stable configuration unique to Nigeria, or does it characterise entrepreneurial adaptation across emerging economies with volatile infrastructures? Comparative studies could extend TOE by identifying whether hybridity generalises or whether different equilibrium strategies emerge under varying voids. Second, our results suggest that digital maturity operates as a threshold construct. Longitudinal research could investigate how firms transition between maturity stages, testing whether crossing integration thresholds produces nonlinear performance jumps. Such studies would further refine TOE's technological domain by embedding maturity within processual models of capability development. Third, while this study employed cross-sectional survey methods, future research should adopt mixed-methods and longitudinal designs. Ethnographic or qualitative work could illuminate how entrepreneurs improvise hybrid models in practice, complementing our quantitative results, while panel data could strengthen causal inference regarding maturity and performance.

Boundary conditions also warrant exploration. Our evidence derives from Nigeria, but the theoretical refinements proposed here invite testing in comparative contexts. Future research should explicitly contrast developed and emerging economies to examine how TOE operates under differing institutional conditions. For instance, in developed economies, where infrastructure and policy reliability are assumed to be reliable, does digital maturity still exhibit threshold dynamics? Or is the nonlinearity observed here unique to fragile environments? Such studies would clarify the scope conditions of TOE, offering a more globally integrated theory of digital entrepreneurship. Finally, future research should extend the analysis to sectoral ecosystems, exploring how sector-specific institutions interact with organisational strategies. For example, do fintech and healthtech entrepreneurs face different barriers in scaling advanced maturity than agritech ventures, and what does this imply for TOE's environmental dimension?

In conclusion, this study contributes to theory by advancing TOE into a contingent, context-sensitive framework that explains digital entrepreneurship in institutional voids. It demonstrates that digital transformation in Nigeria is not a linear march toward full digitisation but a recalibration of strategies under structural constraints. Hybridity emerges as a rational equilibrium, maturity delivers nonlinear returns, and barriers act as structural determinants. These refinements enrich TOE by embedding it within dynamic capabilities, institutional voids, and entrepreneurship-as-practice perspectives. Empirically, the study provides rare quantitative evidence from Nigeria, advancing knowledge of how digital trajectories unfold in emerging markets. Practically, it highlights the imperative for systemic interventions in infrastructure, cost structures, and skill-building to unlock the transformative potential of digital entrepreneurship. Collectively, these insights suggest that digital entrepreneurship in emerging economies is less about unbounded technological opportunity and more about the strategic navigation of structural constraints, offering a fresh lens through which scholars and practitioners can understand, support, and theorise the digital futures of fragile institutional contexts.

[INSERT TABLE 6 HERE]

REFERENCES

Aina, O., Aime, P. & Lazar, R. (2022) 'Barriers in digital transformation in small and medium enterprises in Nigeria', *International Journal of Innovation in the Digital Economy*, 13(1), pp. 1–17. https://doi.org/10.4018/ijide.311510

Baker, J. (2011). The technology–organization–environment framework. *Information Systems Theory: Explaining and Predicting Our Digital Society, Vol. 1*, 231-245.

Chatterjee, I., Cornelissen, J., & Wincent, J. (2021). Social entrepreneurship and values work: The role of practices in shaping values and negotiating change. *Journal of Business Venturing*, *36*(1), 106064.

Chen, A., Lin, Y., Mariani, M., Shou, Y. and Zhang, Y., (2023) Entrepreneurial growth in digital business ecosystems: An integrated framework blending the knowledge-based view of the firm and business ecosystems. *Journal of Technology Transfer*, 48(5), pp.1628–1653. https://doi.org/10.1007/s10961-023-10027-9.

Chen, J. & Liu, L. (2023) 'Social media usage and entrepreneurial investment: An information-based view', *Journal of Business Research*, 155, 113423. https://doi.org/10.1016/j.jbusres.2022.113423.

Clark, R. C., & Mayer, R. E. (2023). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. john Wiley & sons.

Clark, R.C. & Mayer, R.E. (2023) *E-learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*. 4th ed. Hoboken, NJ: Wiley. https://doi.org/10.1002/9781119239086.

Cohen, J. (1992) 'A power primer', *Psychological Bulletin*, 112(1), pp. 155–159. https://doi.org/10.1037/0033-2909.112.1.155.

Cornelissen, J. P. (2025). The problem with propositions: Theoretical triangulation to better explain phenomena in management research. *Academy of Management Review*, *50*(2), 342-365.

D'Angelo, S., Cavallo, A., Ghezzi, A., & Di Lorenzo, F. (2024). Understanding corporate entrepreneurship in the digital age: a review and research agenda. *Review of Managerial Science*, *18*(12), 3719-3774.

Dong, J. Q. (2021). Technological choices under uncertainty: Does organizational aspiration matter?. *Strategic Management Journal*, *42*(5), 898-916.

Eckert, C. and Hohberger, J., (2023) Addressing endogeneity without instrumental variables: An evaluation of the Gaussian copula approach for management research. *Journal of Management*, 49(4), pp.1460–1495. https://doi.org/10.1177/01492063221085913.

Ediagbonya, V., & Tioluwani, C. (2023). The role of fintech in driving financial inclusion in developing and emerging markets: issues, challenges and prospects. *Technological Sustainability*, *2*(1), 100-119.

Ehret, M. and Olaniyan, R. (2023) 'Banking the unbanked: Constitutive rules and the institutionalization of mobile payment systems in Nigeria', *Journal of Business Research*, 163, 113845. https://doi.org/10.1016/j.jbusres.2023.113845.

Farhat, R., & Yang, Q. (2025). Entrepreneurs' adoption of social media winning platform (s) in emerging markets. *International Journal of Internet Manufacturing and Services*, *11*(2), 153-170.

Felicetti, A.M., Corvello, V. & Ammirato, S. (2024) 'Digital innovation in entrepreneurial firms: A systematic literature review', *Review of Managerial Science*, 18(2), pp. 549–596. https://doi.org/10.1007/s11846-023-00638-9

Garcez, A., Silva, R. and Franco, M. (2022) 'Digital transformation shaping structural pillars for academic entrepreneurship: A framework proposal and research agenda', *Education and Information Technologies*, 27, 1159–1182. https://doi.org/10.1007/s10639-021-10638-5.

Guo, X., Li, M., Wang, Y. and Mardani, A. (2023) 'Does digital transformation improve the firm's performance? From the perspective of the digitalization paradox and managerial myopia', *Journal of Business Research*, 163, 113960. https://doi.org/10.1016/j.jbusres.2023.113960.

Hortoványi, L. and Szász, L. (2023) 'Assessment of digital maturity: The role of resources and capabilities', *International Journal of Production Research*, 61(7), 2140–2163. https://doi.org/10.1080/00207543.2022.2138509.

Huang, F.L. (2022) 'Accounting for heteroskedasticity resulting from between-group variability', *Multivariate Behavioral Research*, 57(3), 421–437. https://doi.org/10.1080/00273171.2022.2077290.

Iheanachor, N., Umukoro, I.O., Yela, U. and Aránega, A.Y. (2023) 'Digital financial services in Nigeria: Ecosystem emergence, development, and sustainability', *Technological Forecasting & Social Change*, 190, 122361. https://doi.org/10.1016/j.techfore.2023.122361.

Irele, A.O., (2021) Digital integration into the Nigerian educational system: challenges and prospects. *Texila International Journal of Academic Research*, 8(1), pp.1-7. doi:10.21522/tijar.2014.se.21.01.art003.

Keller, R., Weiblen, T. and Vetterli, T. (2022) 'Pathways to developing digital capabilities', *Business & Information Systems Engineering*, 64, 119–134. https://doi.org/10.1007/s12599-021-00696-9.

Ketchen, D.J., Kaufmann, L. and Carter, C.R. (2022) 'Configurational approaches to theory development in supply chain management: Leveraging underexplored opportunities', *Journal of Supply Chain Management*, 58(3), 71–88. https://doi.org/10.1111/jscm.12277.

Khanna, T. and Palepu, K., 2023. Institutional voids, infrastructure, and digital strategies in emerging economies. *Academy of Management Perspectives*, 37(2), pp.240–259. https://doi.org/10.5465/amp.2021.0043.

Kraus, S., Palmer, C., Kailer, N., Kallinger, F. and Spitzer, J., (2019). Digital entrepreneurship: a research agenda on new business models for the twenty-first century. *International Journal of Entrepreneurial Behavior and Research*, 25(2), pp.353-375. doi:10.1108/ijebr-06-2018-0425.

Lu, Z., Mahalik, M. K., Mallick, H., & Zhao, R. (2022). The moderating effects of democracy and technology adoption on the relationship between trade liberalisation and carbon emissions. *Technological Forecasting and Social Change*, *180*, 121712.

Malekpour, M., Sedighi, M., Caboni, F., Basile, V., & Troise, C. (2025). Exploring digital transformation and technological innovation in emerging markets. *International Journal of Emerging Markets*, *20*(13), 96-121.

Malekpour, M., Sedighi, M., Caboni, F., Basile, V., & Troise, C. (2025). Exploring digital transformation and technological innovation in emerging markets. *International Journal of Emerging Markets*, *20*(13), 96-121.

N'Dri, A.B. and Su, Z. (2024) 'Successful configurations of technology–organization–environment factors in digital transformation: Evidence from exporting SMEs in the manufacturing industry', *Information & Management*, 61(5), 104030. https://doi.org/10.1016/j.im.2024.104030.

Niankara, I., (2024) Evaluating the influence of digital strategy on the interplay between quality certification and sales performance using data science and machine learning algorithms. *Journal of Open Innovation: Technology, Market, and Complexity*, 10(3), p.100354. doi:10.1016/j.joitmc.2024.100354.

Nkechika, C., (2022) Digital financial services and financial inclusion in Nigeria: milestones and new directions. *Central Bank of Nigeria Economic and Financial Review*, 60(4), pp.151-170.

Nkwo, F.N. and Eneiga, R.U., 2024. Entrepreneurship development in Nigeria: overcoming challenges and expanding opportunities in the digital economy. *Sadi International Journal of Management and Accounting*, 11(3), pp.1-14. doi:10.5281/zenodo.12607420.

Nura, A.Y., 2022. Factors influencing adoption of agricultural technologies amongst African Development Bank community-based agriculture and rural development project beneficiaries in Nigeria. *Nigerian Journal of Agriculture and Agricultural Technology*, 2(1), pp.46-54. doi:10.59331/njaat.v2i1.6.

Nwankwo, F.O. and Okeke, C.S., (2017) Rural entrepreneurship and rural development in Nigeria. *Africa's Public Service Delivery and Performance Review*, 5(1), p.a152. doi:10.4102/apsdpr.v5i1.152.

Okoye, N., (2025) The role of digital transformation in shaping entrepreneurial ventures in Nigeria. *Ékwé International Journal of Igbo Scholars Forum for Socio-Cultural Advancement*, 18(2), pp.1-29.

Olanrewaju, A.T., Hossain, M.A., Whiteside, N. & Mercieca, P. (2020) 'Social media and entrepreneurship research: A literature review', *International Journal of Information Management*, 50, pp. 90–110. https://doi.org/10.1016/j.ijinfomgt.2019.05.011

Osabutey, E.L.C. and Jackson, T. (2024) 'Mobile money and financial inclusion in Africa: Emerging themes, challenges and policy implications', *Technological Forecasting & Social Change*, 202, 123339. https://doi.org/10.1016/j.techfore.2024.123339.

Otoo, G.E., Amponasah, R., Afful-Dadzie, E. and Kolog, E.A., (2023) Digital transformation of SMEs through social media. In: *The 9th African Conference on Information Systems and Technology*. pp.2-11.

Oyedele, O.O. and Oyero, M.A. (2022) 'Techno-entrepreneurship pathway to sustainable business performance: Empirical evidence from SMEs in Ogun State, Nigeria', *World Review of*

Entrepreneurship, Management and Sustainable Development, 18(5/6), 545–565. https://doi.org/10.1504/WREMSD.2022.125217.

Peprah, A.A., Khan, Z., Meyer, M. and Laker, B. (2024) 'Nonmarket strategy and legitimacy in weak institutional contexts', *International Business Review*, 33(5), 102258. https://doi.org/10.1016/j.ibusrev.2023.102258.

Pindado, E., Kanda, W. and Makri, K. (2023) 'International entrepreneurship in Africa: The roles of institutional voids, entrepreneurial networks and gender', *Journal of Business Research*, 166, 114109. https://doi.org/10.1016/j.jbusres.2023.114109.

Raithatha, R., Awanis, A., Lowe, C., Holliday, D., & Storchi, G. (2023). GSMA State of the Industry Report-Mobile for Development.

Samuel, L. (2025). The Relationship Between Technological Factors and Technology Readiness of Humanitarian Organizations to offer Digital Cash Assistance: A Case Study of Kampala, Uganda. *Uganda (May 08, 2025)*.

Satalkina, L. & Steiner, G. (2020) 'Digital entrepreneurship and its role in innovation systems: A systematic literature review as a basis for future research avenues for sustainable transitions', *Sustainability*, 12(7), 2764. https://doi.org/10.3390/su12072764

Schneider, V., & Willimowski, M. C. (2025). Trusting the Unperceived: How does Artificial Intelligence shape Decision-Making?.

Sebastian, I.M., Ross, J.W. & Beath, C.M. (2022) 'How big old companies navigate digital transformation', *MIS Quarterly Executive*, 21(1), pp. 35–51. https://doi.org/10.17705/2msqe.00071

Suleiman, U.Y., Daura, A.H. and Liberty, F.S., (2023) Public policy inconsistency and economic development in Nigeria. *UBS Journal of Business and Economic Policy*, 1(3), pp.148-160.

Sunday, O.N., Umeifekwem, U.T. and Eme, O.I., (2023) Addressing digital technology gap challenges: the Nigerian experience. *Nigerian Journal of Social Development*, 11(1), pp.95-100.

Tidjani, C. and Madour, A., 2024. Fintech, financial inclusion, and sustainable development in the African region. *Applied Mathematics and Statistics*, 10, pp.1-25. doi:10.3389/fams.2024.1276218.

Vaithilingam, S., Ong, C.S., Moisescu, O.I. and Nair, M.S. (2024) 'Robustness checks in PLS-SEM: A review of recent practices and recommendations for future applications in business research', *Journal of Business Research*, 173, 113824. https://doi.org/10.1016/j.jbusres.2023.113824. IDEAS/RePEc

Verhoef, P.C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J.Q., Fabian, N. & Haenlein, M. (2021) 'Digital transformation: A multidisciplinary reflection and research agenda', *Journal of Business Research*, 122, pp. 889–901. https://doi.org/10.1016/j.jbusres.2019.09.022

Zhu, Z. Y., Xie, H. M., & Chen, L. (2023). ICT industry innovation: Knowledge structure and research agenda. *Technological Forecasting and Social Change*, *189*, 122361.

Table 1. Synthesis of Hypotheses, TOE Dimensions, and Supporting Literature

Hypothesis	Construct / Relationship	TOE Dimension	Supporting Literature	Summary Insight
H1	Hybrid business models → Sectoral focus (fintech, edutech, agritech, healthtech)	Organisational / Environmental	Okoye (2025); Garcez et al. (2022, *Education and Information Technologies*); Clark & Mayer (2016)	Hybrid models act as adaptive equilibria, enabling participation in high-potential sectors while buffering infrastructural fragility.
H2	Digital tool adoption → Business performance outcomes	Technological / Organisational	Oyedele & Oyero (2022); Otoo et al. (2023); Chen & Liu (2023, *Journal of Business Research*); Niankara (2024)	Adoption breadth and depth enhance efficiency and competitiveness, though advanced tools remain unevenly adopted.
H3	Digital maturity levels → Business performance outcomes (revenue, customers, efficiency, market reach)	Technological / Organisational	Felicetti et al. (2023); Niankara (2024); Drummond et al. (2018, *Industrial Marketing Management*)	Advanced maturity delivers transformative performance gains, whereas intermediate levels plateau due to infrastructural constraints.
H4	Barriers (infrastructure, costs, skills, policy) → Digital adoption and maturity levels	Environmental	Aina et al. (2022); Sunday et al. (2023); Nkwo & Eneiga (2024); Suleiman et al. (2023); Okoye (2025)	Environmental voids actively truncate adoption trajectories, producing a dual-speed digital economy.

Table 2. Assumption Checks, ANCOVA Robustness, and Contextual Analyses

Test/Model	Revenue Gen.	Customer Acq.	Efficiency	Market Exp.	Note
Levene's Test (p)	.128	.189	.098	.115	No variance heterogeneity
Welch's ANOVA (p)	.000	.000	.000	.000	Robust to non-normality
ANCOVA F (with covariates)	112.08***	95.10***	92.54***	48.17***	Sector & firm size controlled.
VIF (max)	1.45	1.45	1.45	1.45	No collinearity
Urban F (p)	124.31***	107.89***	95.64***	52.90***	Stronger urban effects
Rural F (p)	65.27***	58.18***	54.76***	33.17***	Effects present but weaker
Endogeneity IV check	Positive sig.	Positive sig.	Positive sig.	Positive sig.	Sector infra. as IV
CMV test	<30% variance	<30% variance	<30% variance	<30% variance	No single factor bias

Note: ***p < .001. Tests confirm the robustness, validity, and stability of the results across various contexts.

Table 3. Demographic, Organisational, and Adoption Profiles

Category	Key Findings	Implications for TOE Dimensions
Age/Education	45.6% aged 26–35; 79.8% tertiary	Organisational absorptive capacity facilitates adoption
Geography	44.3% Southwest; <14% North	Environmental disparities shape adoption trajectories
Role/Sector	45.6% entrepreneurs; 41.8% services	Private actors drive adoption; services digitise faster
Location	73.4% urban	Infrastructure advantages amplify performance
Tool Adoption	Social media 94.9%; payments 74.7%; AI/Cloud <33%	Two-speed ecosystem: mass basic vs. selective advanced tools
Adoption Drivers	Market expansion 87.2%; optimisation 83.5%	Strategic, proactive adoption orientation
Maturity Levels	27.8% beginner; 62.0% intermediate; 10.1% advanced	Nonlinear maturity; thresholds critical for performance

Table 4. Hypothesis Test Results

Hypothesis	Test/Model	Key Result	Inference
H1	χ^2 (3) = 45.31, p < .001	Hybrid models → fintech, edutech, agritech	Supported
H2	ANOVA F > 46, p < .001; OLS β > 0, p < .001	Adoption → higher revenue, customers, efficiency, expansion	Supported
H3	ANOVA F > 52, p < .001; OLS β (Advanced > Intermediate > Beginner)	Nonlinear maturity → convex performance benefits	Supported
H4	ANOVA F = 82.47, p < .001; OLS β < 0	Barriers structurally truncate integration	Supported

Table 5. PLS-SEM Structural Path Results

Path	β	t-value	p-value	Result
Maturity → Adoption	0.41	8.21	.000	Supported
Adoption → Performance	0.37	7.64	.000	Supported
Barriers → Adoption	–0.29	6.12	.000	Supported
Maturity × Barriers → Adoption	–0.15	2.71	.007	Supported

Note: R^2(Adoption) = .46; R^2(Performance) = .52. All constructs reliable and valid.

Table 6. Contributions of the Study

Dimension	Key Insights	Contribution	Future Research Directions
Empirical	Demonstrated significant effects of digital maturity, tool adoption, and barriers on entrepreneurial performance in Nigeria (e.g., ANOVA results: Revenue F = 115.80, p < .001).	Provides rare large-sample, quantitative evidence from an emerging economy; quantifies nonlinear maturity–performance	Extend analysis with longitudinal data to capture trajectories of digital maturity; broaden to comparative cross-country studies.

		effects and structural impact of barriers.	
Theoretical	Advanced the Technology–Organisation–Environment (TOE) framework by: (1) reconceptualising digital maturity as nonlinear/threshold-based; (2) theorising hybridity as a stable equilibrium; (3) reframing barriers as structural determinants.	Extends TOE into a contingent theory of digital entrepreneurship in institutional voids, integrating insights from dynamic capabilities, institutional voids, and entrepreneurship as a practice.	Examine whether hybridity generalises across institutional contexts; test TOE boundary conditions in developed vs. emerging economies.
Practical/Policy	Findings highlight that infrastructural deficits, high costs, and skill gaps act as structural constraints. Hybridity emerges as a rational strategy in the face of infrastructural fragility.	Position policy interventions (infrastructure, cost reduction, skill-building) as foundational levers for enabling digital transformation.	Explore sector-specific interventions (e.g., fintech vs. agritech) and their role in overcoming structural barriers.
Future Research Agenda	The current study used a cross-sectional survey design; findings highlight uneven adoption (breadth vs. depth).	Provides a framework for integrating adoption, maturity, and environmental barriers in fragile ecosystems.	Combine qualitative and quantitative methods; analyse ecosystem-level interactions; explore regional digital divides in more depth.

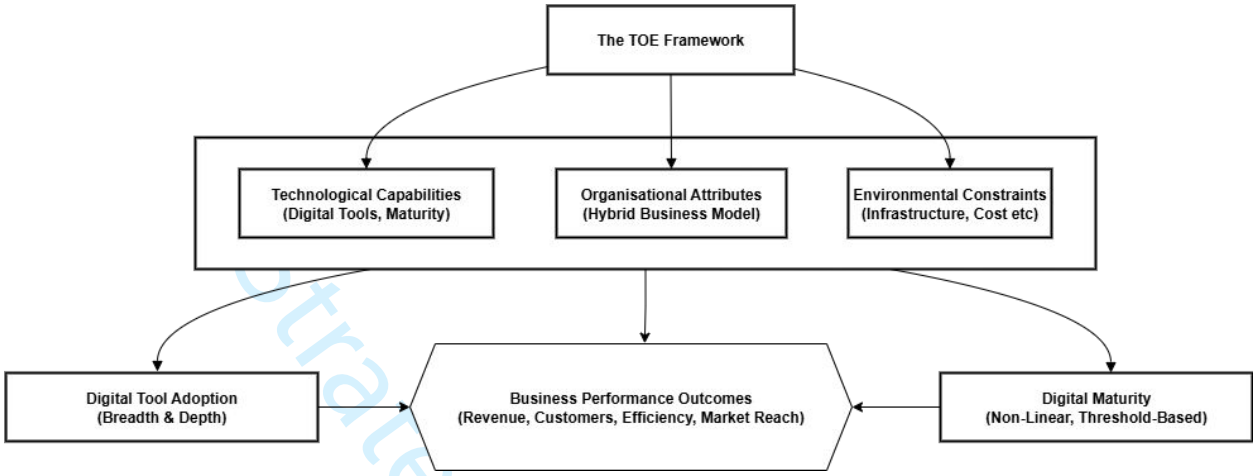

Figure 1. Conceptual framework of the study