Digital Innovation and Customer Effort Score: The Mediating Role of Competitive Intensity

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ABSTRACT

This study investigates the mediating role of competitive intensity in the relationship between digital innovation and customer effort score within the commercial banking sector of North Central Nigeria. Grounded in the Dynamic Capabilities Perspective and Service-Dominant Logic, the research addresses the critical need to understand how digital banking advancements minimise transactional, operational, and cognitive friction for retail customers. Utilising a quantitative, cross-sectional survey research design, data were gathered from 400 active digital banking users across twelve strata using a stratified quota sampling technique. Structural Equation Modeling via SmartPLS 4 was employed to evaluate direct and indirect pathways. The empirical findings reveal that digital innovation exerts a statistically significant positive effect on optimising customer effort scores ($\beta = 0.155, p = 0.001$). Furthermore, competitive intensity acts as a significant partial mediator ($\beta = 0.046, p = 0.002$), demonstrating that technological deployments heighten market rivalry, which subsequently compels banks to streamline digital user journeys and eliminate service bottlenecks. The study provides vital implications for bank executives and policymakers on leveraging regional competitive dynamics through digital investment to improve electronic banking service delivery.

Keywords: Digital Innovation; Customer Effort Score; Competitive Intensity; Commercial Banks.

INTRODUCTION

The digital transformation of the global economy has ushered banking institutions away from transaction-based operation models, towards frictionless customer journeys (Adekoya & Okunlola, 2023; Dwivedi et al., 2021). In national financial ecosystems where current industry disintermediation pressures from non-bank Fin Tech disrupters and regulatory technology regimes threaten to destabilize industry consensus, incumbent banking institutions leverage Digital Innovation to retain their control over customer bases (Olayinka et al., 2022; Uzor & Chukwu, 2024). As the traditional service quality approach has shifted from high transaction satisfaction levels to minimalist customer effort through the cognitive outsourcing of routine transactions, the Customer Effort Score has become the dominant digital trust and consumer loyalty metrics for retail banking service users (Dixit et al., 2021; Santillan et al., 2023).

Though there has been an abundant deployment of omnichannel platforms, AI customer contact and mobile apps, the impact of digital innovation to ease customer effort has been heterogenous across developing socio-economic spaces (Ameseguin & Olayemi, 2025; Nwankwo et al., 2023). This disparity is especially evident in North Central Nigeria, where a geocluster characterised by a mix of nascent urban commercial hubs (Abuja, Ilorin) and neglected peri-urban communities challenged by poor infrastructural support, network lag and digital literacy (Bello et al., 2024; Ibrahim et al., 2022). In such regional contexts, the deployment of digital solutions does not automatically translate to low-effort experiences for bank customers. Instead, the deployment of internal technological innovations influences external market conditions by escalating regional Competitive Intensity and buoying tier-1 and tier-2 banks to steal a share of the market from nimble, digital-only rivals (Nnamdi & Eze, 2023; Obalade & Ojo, 2022).

First, through the lens of theory, this relationship can be summarized using the Dynamic Capabilities Perspective (Teece, 2021), and Service-dominant Logic (Vargo & Lusch, 2022). Dynamic capabilities imply that digital innovation at the firm level allow banks to regenerate resources at the bank to effectively cope with environmental change. But as banks deploy reach-scaled digital enablers, regional competition heightens;

because competitors need to unclog friction points to continue pre-positioning their depositors (Mittal et al., 2023). The existing literature mostly treats competitive intensity as an external (envionmental) moderator or exogenous market condition (e.g., Al-Haderi et al., 2023; Wilden et al., 2022). Few empirical studies treat competitive intensity as an endogenous mediating mechanism through which technological innovations translate into tangible customer-level consequences (CES) in the context of Sub-Saharan Africa banks (Eke et al., 2024; Yusuf & Lawal, 2025).

Against the backdrop above, this study has sought to fill this research gap by investigating the mediating role played by competitive intensity on digital innovation and customer effort score of some commercial banks in North Central Nigeria. This study shows how digital innovations generate competitive pressure, forcing banks to improve their digital interface, allow seamless digital onboarding and eliminate delays at touch points. This study seeks to answer the research question:

What is the mediating role of competitive intensity on the relationship between digital innovation and customer effort score of banks in north central nigeria?

This research makes three important conceptual and practical contributions. The first contribution extends the emerging Dynamic Capabilities Perspective by validating market-level competitive intensity as an instrumental structural mediator, not merely a passive boundary condition, that is situated between firm digital capabilities and the resulting service performance dimensions (Teece, 2021;Yusuf and Lawal, 2025). The second contribution advances the digital banking literature in SSA by identifying Customer Effort Score as a third key outcome measure that complements existing macro-level service quality measures, rich in financial metrics, to capture user friction at the micro-level (Dixit et al., 2021; Santillan et al., 2023). Finally, the paper provides relevant and actionable strategic interventions, on the part of bank managers and financial regulators, to leverage regional levels of competition through digital adoption and investments to create a frictionless, low effort financial services experience for users.

LITERATURE REVIEW

Digital Innovation in Banking

Digital Innovation in commercial banking is essentially a strategic, managerial endeavour not a merely technological pursuit by the IT department (Vial, 2021). It involves recombining digital technology to engineer innovative financial offerings and service touch points as well as to redesigned client value prepositions in a world that is becoming increasingly digitally mode (Nambisan et al., 2019; Yoo et al., 2010). Digital innovation can be construed as a disruptive transformation that impacts the intrinsic properties of an entity through integrated information, connectivity and computing which has much relevance for financial services as DI can help deposit money banks not just automate operational activities but completely reimagine the paradigm of engaging and managing retail transactions (Olayinka et al., 2022). From the vantage point of Dynamic Capabilities Perspective, building capabilities to sense digital market trends, to digitalize digital opportunities and reconfigure bank business operations is critical in remaining technologically relevant (Teece, 2021; Warner & Wäger, 2019). Digital strategy by leading banks, to articulate a digital vision and remove silos can go hand in hand with a culture of experimenting in driving value from digital technology investments into market competitiveness (Kane et al., 2021)

Technological Enablers of Digital Banking Innovation

The resulting technological architecture supporting that underpins digital banking innovation in Nigeria has become highly synergistic, with each layer directly focused on customer effort reduction. Cloud infrastructure supports high-volume transaction environments; big data analytics and artificial intelligence underpin real-time risk scoring algorithms and personalised engagement; biometrics and application programming interfaces (APIs) deliver fully open-banking integration, and next-generation telecom infrastructure delivers truly frictionless mobile banking (Ameseguin & Olayemi, 2025; Verhoef et al., 2021). Instead of working independently, these technologies will be able to combinatorially reduce the friction involved in a traditional banking transaction – such as pre-qualifying an online transaction with a biometric or risk score, streaming millions of transaction details to a cloud server for machine learning models to then identify a pattern of fraudulent behaviour, and automatically booking a customer's digital onboarding via the application

programming interface.

Additionally, the advent of generative AI and the automation of self-service processes have revolutionized front-office customer interactions, offering scalable solutions that significantly reduce turnaround time in digital channels (Trabucchi et al., 2024). In the regional setting of North Central Nigeria where commercial banks' customers in cities like Abuja, Ilorin, and Jos are constantly subjected to network delays, channel breakdowns, and service disruptions these digital technologies serve as mitigating tools to limit cognitive, physical and operational efforts (Bello et al., 2024; Santillan et al., 2023). Nevertheless, the adoption of sophisticated tech stacks does not occur in the absence of market dynamics. As commercial banks lead the charge in providing frictionless channels, rivalry among market players intensifies across the region. Competing financial institutions are compelled to continually elevate the perceived ease of interaction with their digital platforms by refining user interfaces, reducing network disruptions and lowering digital effort, lest they lose existing customers to rivals (Eke et al., 2024; Yusuf & Lawal, 2025). Consequently, DI is an organisational (bank-level) characteristic. It is operationalised as the respondent's perception of the functional depth, process automation, predictive interfaces and platform capabilities of the digital channels of the bank he or she uses. As a result, it is a perceived, customer-reported measure of the bank's innovation, not an objective record such as technology expenditure. A higher score indicates greater perceived digital innovation.

Customer Effort Score

Digital innovation in retail banking is driven by the reshaping of customer experience from customer delight and passive satisfaction to seamless interaction. Initial studies have used broad indicator such as Customer Satisfaction and Net Promoter Score, but later studies in the service marketing literature have already defined customer's effort reduction as a better indicator of retention and channel switching (Dixit et al., 2023; Santillan et al., 2023). Customer Effort Score (CES) refers to the customer's perception of the cognitive, physical and time-related effort required to complete a transaction, such as executing an interbank transfer, reversing a failed transfer, or initiating a transaction on a mobile device (Dixon et al., 2010; Mittal et al., 2023; Nwankwo et al., 2023). In this study CES is scored in the direction of ease, so that a higher score indicates lower perceived effort.

In retail banking, digital innovation comprises of low effort interactions with features such as friendly banking apps, free USSD codes, biometrics and ACDs (Ameseguin & Olayemi, 2025). In North Central Nigeria-where bank customers in commercial banking hubs such as Abuja and Ilorin, as well as mobile bank accounts in Kogi, Benue and Nasarawa, constantly experience delays in network, slow dispense time, and increased authentication steps that reduce effort, digital innovation isn't enough- competitive intensity of commercial banks is the critical antecedent (Eke et al., 2024). As banks continue to innovate with defensive digital solutions against rival banks, they compete to optimise user interfaces, hasten onboarding and fast-track payments (Nnamdi & Eze, 2023). Hence, under competitive pressures, commercial banks can leverage digital innovation to enhance complex routines into low-effort customer journeys across North Central Nigeria (Yusuf & Lawal, 2025). Conceptually, CES is a customer-level perception. The direction of the scale for customer effort score is measured with ease-oriented statements (onboarding ease, issue-resolution speed, interface simplicity and low transactional friction)

Competitive Intensity

Digital innovation is not a strategic vacuum; it modifies the external environment, including the competitive environment. Competitive Intensity indicates the extent of competition, market confrontation, and firms' posturing and strategising among competitors in a given industry (Jaworski & Kohli, 1993; Obalade & Ojo, 2022). It is therefore a market-level condition that lies outside any single bank, in contrast to digital innovation, which is a bank-level characteristic. And as the first movers of digital services in Commercial Banks, the boundaries of competition become very thin.

In Nigeria's financial services ecosystem, the strong competition induced by disintermediation from Fin Tech firms, payment service banks and digital-only micro finance institutions has introduced intense market competition (Nnamdi & Eze, 2023). When much of the core banking features are digitised by tier-1 and tier-2 banks, the competition is forced to imitate digital features, reduce transaction fees and increase platform reliability. In this manner, intensity of competition has thus become an endogenous intervening construct as di-

gital innovation increases competition in the banking ecosystem, which creates subsequent pressure on the financial institutions to continually optimise touchpoints and reduce customer effort to hedge against deposit flight and customer churn (Eke et al., 2024; Yusuf & Lawal, 2025). Because the study does not use objective market indicators such as concentration ratios or the number of competitors, Competitive Intensity is operationalised as the respondent's perception of market rivalry, the rate of competitive actions and the threat of FinTech substitutes in the banking market. A higher score indicates more intense perceived competition.

Summary of levels. Digital Innovation is an organizational characteristic, Competitive Intensity is a market-level condition, and Customer Effort Score is a customer-level perception. All three are nevertheless observed through the same respondent-level questionnaire, so DI and CI represent customers' perceptions of the bank and of the market and not objective firm-level or market-level data. This single-source feature is acknowledged as a limitation of the study.

Theoretical Review

The conceptual model for this paper integrates the theories of the Dynamic Capabilities Perspective (Teece, 2021) and Service-Dominant Logic (Vargo & Lusch, 2022) which collectively describes the mechanism of technology deployment at the firm-level to diminish customer friction. Per the Dynamic Capabilities Perspective, firms repeatedly need to sense, seize, and reconfigure competences to maintain competitive alignment. This paper applies this perspective to retail banking Digital Innovation as it operationalizes dynamic capabilities with scalable cloud infrastructure, automated self-service channels and artificial intelligence enabled consumer interfaces (Ameseguin & Olayemi, 2025; Mittal et al., 2023). However, this is not undertaken in a vacuum as novelty in digital capabilities severely distorts market equilibrium, multiplying regional Competitive Intensity at competing commercial banks (Eke et al., 2024; Wilden et al., 2022). The paper further attributes the credit of the Customer Effort Score as the primary indicator of transactional cheer to the theory of Service-Dominant Logic which notes that value is created during the service encounter and that intense competitive rivalry directly forces banks to continually adapt consumer-facing digital interfaces, prune operational bottlenecks and optimize channel stability for customer retention (Santillan et al., 2023; Nnamdi & Eze, 2023; Yusuf & Lawal, 2025).

Empirical Review

This section overviews past empirical research related to the causal relationships theorized in the proposed relationships between digital innovation, competitive intensity, and customer effort. As few papers employ a CES model of research, we rely on research that tests the connection between digital capabilities, competitive environment, and customer–facing performance, and describes where the evidence falls short of our model.

Martínez de Miguel et al. (2022) tested customer satisfaction as a mediating effect of digital transformation in the automotive industry. They studied firms in Spain and received 42 valid questionnaires, which they analysed with a 2-stage PLS-SEM and 5,000 bootstrap resamples. Sensing, seizing, and innovation contributed to one shared dynamic-capability factor that revealed a positive impact on customer satisfaction ($\beta = 0.673$, $p < 0.001$; $R2 = 0.453$). The authors suggest collecting customer-contact data from digital channels to anticipate needs and streamline processes. There are two concerns for this study: the sample is small and skewed towards larger firms, and the model considers the competitive environment only as a background rather than as a driver. As with a related outcome, the bottom-line shows that investing in digital capabilities led to sustainable business performance (Chen et al., 2024); this was explained by market-oriented business model innovation, and digital leadership has a moderating effect. Customer value is implicit here but was not tested (see also: perceived effort).

A second strand considers competitive pressure as an antecedent that influences a firm's use of digital resources. Giantari et al. (2022) conducted a survey of 210 Bali culinary SMEs with purposive sampling and PLS-SEM. Competitive intensity and the COVID-19 pandemic attenuated both financial and non-financial performance, and adoption of digital marketing mediated these relationships for non-financial but not financial performance; non-financial performance encompasses customer outcomes. This indicates that digital platforms mitigate the costs that highly competitive markets impose on customer outcomes, while not reducing the finan-

cial costs enough to eliminate significant net costs. Work on digital transformation in manufacturing leans towards the same conclusion: findings from Chinese manufacturing exporters show that digital transformation increases enterprise performance, partly through reductions in operating costs, and partly through mediators like higher R&D intensity and stronger human resources (Wang et al., 2024). Employees' work shows competition as a distal predictor of work digitalisation that influences job performance through digitalisation, rather than modelling it as a mediator between digitalisation and job performance (Liu et al., 2025). While neither model competitive intensity as a predictor of digitalisation of the customer side, both show that competitive rivalry nudges firms toward digitalisation and that digitalisation transmits this relationship's effects.

Research Gap

While existing research acknowledges that digital capabilities influence customer-oriented and organizational consequences (Chen et al., 2024; Martínez de Miguel et al., 2022; Wang et al., 2024), there are still vital empirical gaps on intervening processes, measurement of the consequence and the effect of different contexts.

First, the conceptualization of competitive intensity is insufficiently specified. Most existing research considers market rivalry and competitive pressure (Jaworski & Kohli, 1993) as a control variable or contextual factor or an exogenous stimulus (Giantari et al., 2022; Liu et al., 2025). Yet, prior research does not empirically test whether digital innovation directly increases market rivalry and forces firms to implement faster service delivery. Conceptualizing competitive intensity as active intervening variable as opposed to a relatively passive boundary condition is consistent with a dynamic capabilities perspective (Teece, 2007), but empirically unexplored. Second, prior digital innovation research has too narrowly adopted aggregate customer satisfaction or broad firm performance as the dependent variable. Notably, prior research fails to consider the Customer Effort Score (CES), a metric of customer friction which is arguably a more accurate predictor of future loyalty than customer satisfaction (Dixon et al., 2010). Since interface design, digital onboarding, and transaction speed directly influence customer effort, satisfaction-oriented outcome studies are likely to be non-generalizable to Customer Effort Score. Third, empirical evidence in the Sub-Saharan African banking industry is lacking. Prior studies typically use small or sector-specific samples outside the banking industry (e.g., Martínez de Miguel et al., 2022). In Nigeria, commercial banks must contend with FinTech competition and regulatory demands for digital banking solutions, while trying to cope with infrastructure imperfections such as network latency. It is unclear whether the hypothesised relationships also apply in North Central Nigeria, given its specific socio-economic characteristics.

This study addresses this gap by examining whether digital innovation reduces customer effort and whether competitive intensity partially transmits this effect. Drawing on the reviewed evidence, the following hypotheses are proposed:

H_{01}: digital innovation has no significant effect on customer effort score.

H_{02}: the mediating role of competitive intensity between digital innovation has no significant effect on customer effort score.

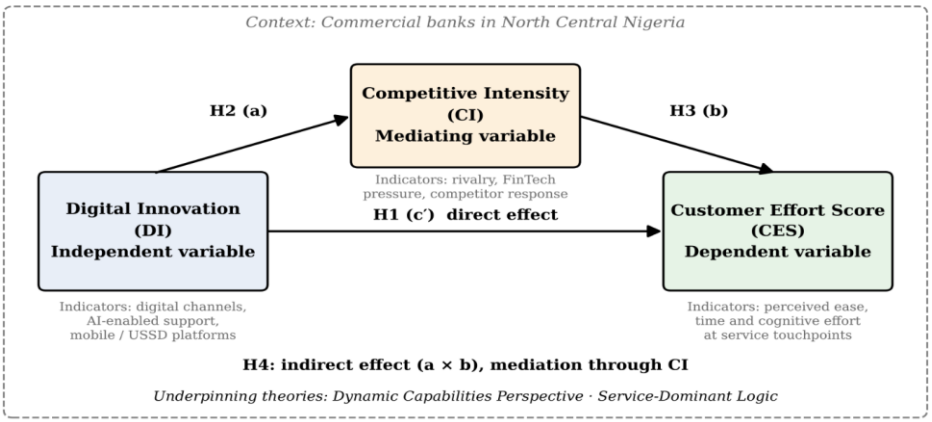

Figure 1: Conceptual framework. Source: Author's conceptualisation (2026).

METHODOLOGY

Research Design

The research design provides an operational framework to ensure the collected data effectively address the research problem and test hypothesised structural relationships. This study utilises a quantitative, cross-sectional survey research design. A quantitative approach is selected to operationalise three abstract constructs, namely Digital Innovation (an organisational characteristic), Competitive Intensity (a market-level condition) and Customer Effort Score (a customer-level perception), into measurable numerical data. Because all three are measured through a customer survey, the unit of analysis is the individual digital banking customer, and each construct is captured as that customer perceives it. This enables the application of statistical and mathematical modeling to determine the strength, direction, and significance of relationships within the commercial banking environment.

The cross-sectional survey strategy involves collecting data from the target population at a single point in time. This strategy provides an accurate empirical "snapshot" of the digital banking landscape and competitive dynamics across the Federal Capital Territory (FCT), Nasarawa, Plateau, and Benue states.

Central to this design is the integration of Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM facilitates the simultaneous evaluation of measurement (outer) models and structural (inner) models. Unlike first-generation regression techniques, PLS-SEM efficiently analyzes complex direct pathways and indirect mediation mechanisms while accommodating latent constructs and non-normal data distributions.

Population of the Study

The target population comprises active digital banking customers of the three leading Tier-1 commercial banks in Nigeria Access Bank Plc, Zenith Bank Plc, and Guaranty Trust Holding Company (GTCO) residing in the North Central Geopolitical Zone (specifically covering FCT-Abuja, Nasarawa, Plateau, and Benue states). Participants are operationally defined as "active digital banking users": individuals who execute financial transactions at least once monthly via digital touchpoints, including mobile banking applications, USSD channels (*901#, *966#, *737#), and internet banking portals. The determination of the population is supported by macro-level institutional market data:

- **Macro-Level Volume:** According to the Nigeria Inter-Bank Settlement System (NIBSS, 2025), active bank accounts in Nigeria reached 320 million in Q1 2025, supported by 66.2 million unique Bank Verification Number (BVN) holders.
- **Institutional Dominance:** Access Bank, Zenith Bank, and GTCO collectively account for over 50% of the national retail banking market share, with customer bases reported at approximately 63 million, 34.5 million, and 32.8 million respectively (Corporate Reports, 2025).
- **Regional Dynamics:** FCT-Abuja represents a high-density administrative hub with high digital literacy, while Nasarawa, Plateau, and Benue represent rapidly expanding digital adoption centers driven by agency banking and tertiary education hubs.

Table 1: Macro-Level Population Indicators

Indicator	Value (2024/2025 Data)	Source
Total Active Bank Accounts (Nigeria)	320 Million (Q1 2025)	NIBSS (2025)
Total BVN-Linked Holders	66.2 Million (July 2025)	NIBSS (2025)
Access Bank Customer Base	63.0 Million	Corporate Report (2025)
Zenith Bank Customer Base	34.5 Million	FY 2024 Report
GTCO (GTBank) Customer Base	32.8 Million	Market Data (2024)

Source: Author's compilation (2025)

Sample Size and Sampling Technique

Because the total number of digital banking users across the study area is extremely large and dynamic, the population is treated as infinite. Cochran's (1977) formula for infinite populations is applied to determine the minimum required sample size at a 95% confidence level and a 5% margin of error:

$$n = \frac{Z^2 \cdot p \cdot q}{e^2}$$

Where:

- $Z = 1.96$ (Critical value for 95% confidence level)
- $p = 0.50$ (Assumed proportion of population variability, maximizing sample size)
- $q = 1 - p = 0.50$
- $e = 0.05$ (Margin of error)

Calculation:

$$n = \frac{(1.96)^2 \cdot (0.50) \cdot (0.50)}{(0.05)^2} = \frac{3.8416 \cdot 0.25}{0.0025} = 384.16$$

To ensure statistical power for PLS-SEM path estimations and to account for non-response or incomplete surveys, the sample size is rounded up to 400 respondents.

The study employs a Stratified Quota Sampling Technique to account for geographical and institutional heterogeneity. The population is divided into twelve (12) distinct strata based on the intersection of the four states (FCT, Plateau, Benue, Nasarawa) and the three Tier-1 banks (Access, Zenith, GTBank). Proportional allocation weights reflect market density across regions and institutions.

Table 2: Distribution of Sample Size Across Strata

State Stratum	State Weight (%)	Bank Stratum	Bank Weight (%)	Allocation Calculation	Sample Size (n)
FCT (Abuja)	40%	Access Bank	40%	$400 \times 0.40 \times 0.40$	64
		Zenith Bank	35%	$400 \times 0.40 \times 0.35$	56
		GTBank	25%	$400 \times 0.40 \times 0.25$	40
Plateau	25%	Access Bank	40%	$400 \times 0.25 \times 0.40$	40
		Zenith Bank	35%	$400 \times 0.25 \times 0.35$	35
		GTBank	25%	$400 \times 0.25 \times 0.25$	25
Benue	20%	Access Bank	40%	$400 \times 0.20 \times 0.40$	32
		Zenith Bank	35%	$400 \times 0.20 \times 0.35$	28
		GTBank	25%	$400 \times 0.20 \times 0.25$	20
Nasarawa	15%	Access Bank	40%	$400 \times 0.15 \times 0.40$	24
		Zenith Bank	35%	$400 \times 0.15 \times 0.35$	21
		GTBank	25%	$400 \times 0.15 \times 0.25$	15
Total	**100%**		**100%**		**400**

Source: Author's compilation (2026)

Method of Data Collection

Data is collected using a structured, self-administered questionnaire. Questions are structured as closed-ended

items rated on a 5-point Likert Scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) (Cooper & Schindler, 2006). All constructs are scored so that a higher value indicates more of the attribute named by the construct; for Customer Effort Score this means greater ease and therefore lower perceived effort.

The instrument is divided into two parts:

Part A: Demographic and operational profiles of respondents (e.g., bank choice, primary digital channel, usage frequency).

Part B: Measurement items capturing the core latent constructs:

Digital Innovation (organisational characteristic, as perceived by the customer): Measuring functional depth, process automation, predictive interfaces, and platform capabilities. A higher score indicates greater perceived digital innovation.

Competitive Intensity (market-level condition, as perceived by the customer): Measuring perceived market rivalry, rate of competitive actions, and threat of FinTech substitutes. A higher score indicates more intense perceived competition.

Customer Effort Score (customer-level perception): Measuring customer onboarding ease, issue resolution speed, interface simplicity, and cognitive/transactional friction. Items are worded as ease statements, so a higher score indicates lower perceived effort.

Method of Data Analysis

Data preparation involves editing, coding, and tabulating responses. Primary statistical estimations are executed using Partial Least Squares Structural Equation Modeling **(PLS-SEM)** via **SmartPLS 4**. PLS-SEM is chosen because it evaluates explained variance (R^2), path estimates (β), and predictive relevance without demanding strict multivariate normality (Hair et al., 2021; Sarstedt et al., 2021).

PLS-SEM evaluation follows a two-stage analytical approach:

1. **Measurement (Outer) Model Evaluation:** Assesses indicator reliability, internal consistency (α, Composite Reliability CR), convergent validity (Average Variance Extracted $AVE \geq 0.50$), and discriminant validity (Heterotrait-Monotrait ratio $HTMT < 0.85$ and Fornell-Larcker criteria).

2. **Structural (Inner) Model Evaluation:** Assesses path coefficients (β), coefficient of determination (R^2), effect sizes (f^2), collinearity ($VIF < 3.3$), and non-parametric bootstrapping (5,000 resamples) to determine the statistical significance of direct and indirect mediation paths.

Reliability and Validity Pilot Testing

A pilot study was conducted with 40 digital banking users (10% of the final sample size) in the FCT to refine instrument clarity and test scale reliability. Internal consistency was evaluated using Cronbach's Alpha (α), adhering to the threshold benchmark of $\alpha \geq 0.70$ (Ritter, 2010).

Table 3: Pilot Scale Reliability Results

Latent Variable / Construct	Number of Items	Cronbach's Alpha (α)	Decision
Digital Innovation (DI)	5	0.78	Reliable
Competitive Intensity (CI)	4	0.79	Reliable
Customer Effort Score (CES)	5	0.76	Reliable

Source: Author's compilation (2026)

Model Specification

Drawing on the theoretical frameworks of Nwachukwu and Vu (2022) and Bello and Musa (2023), the structural model establishes the functional pathways linking Digital Innovation to Customer Effort Score through Competitive Intensity as a mediator.

1. General Baseline Equation:

$$CES_i = \beta_0 + \beta_1 DI_i + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

2. Direct Path Model (Impact of Digital Innovation on CES):

$$CES_i = \beta_0 + \beta_1 DI_i + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

3. Mediation Path Model (Impact of Digital Innovation on Mediator):

$$CI_i = \beta_0 + \beta_2 DI_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

4. Full Structural Model (Total & Indirect Effects):

$$CES_i = \beta_0 + \beta_1^{'DI_i} + \beta_3 CI_i + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where:

- CES_i = Customer Effort Score for respondent i (Dependent Variable)
- DI_i = Digital Innovation score for respondent i (Independent Variable)
- CI_i = Competitive Intensity score for respondent i (Mediating Variable)
- β_0 = Intercept constant
- β_1 = Direct effect parameter of Digital Innovation on CES
- β_2 = Path parameter of Digital Innovation on Competitive Intensity
- β_3 = Direct effect parameter of Competitive Intensity on CES
- β_1' = Direct effect of Digital Innovation on CES controlling for Competitive Intensity
- ε_i = Structural error term

Decision Criteria and Test of Significance

Hypotheses are evaluated at a 5% ($\alpha = 0.05$) significance level. A null hypothesis (H_0) is rejected in favor of the alternative hypothesis (H_1) if the bootstrapping p-value is less than 0.05 ($p < 0.05$) and the corresponding t-statistic exceeds 1.96 ($|t| > 1.96$). Mediation strength is confirmed by evaluating the indirect path significance ($\beta_2 \times \beta_3$) using bias-corrected bootstrapped 95% confidence intervals.

Structural Model and Hypotheses Testing Results

The structural model was evaluated using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 4 to test the direct and indirect hypotheses (Hair et al., 2021). Table 4 demonstrated robust explanatory power, with the digital transformation dimensions jointly explaining 46.9% of the variance in

Customer Effort Score (CES; $R^2 = 0.469$,Adjusted $R^2 = 0.461$) and 36.7% of the variance in the mediator, Competitive Intensity (CI; $R^2 = 0.367$,Adjusted $R^2 = 0.359$).

Table 4: Coefficient of Determination (R^2)

Endogenous Construct	R2	R2 Adjusted	Explanatory Power
Customer Effort Score	0.469	0.461	Moderate / High
Competitive Intensity	0.367	0.359	Moderate

Source: Author's Computation via SmartPLS 4 (2026)

Table 5 below demonstrates that a Direct path evaluation reveals that Digital Innovation exerts a statistically significant positive effect on optimizing Customer Effort Scores ($\beta = 0.155, t = 3.301, p = 0.001$,95% CI [0.058,0.244]), confirming that enhanced digital innovation significantly reduces customer friction during digital service encounters. Thus, H_{01} is rejected.

Regarding the intervening mechanism, empirical findings confirm that Digital Innovation significantly escalates Competitive Intensity ($\beta = 0.193, t = 3.886, p = 0.000$), which subsequently drives Customer Effort Score optimizations ($\beta = 0.237, t = 5.188, p = 0.000$). Bootstrapping with 5,000 resamples verified that the specific indirect effect of Digital Innovation on CES through Competitive Intensity is statistically significant ($\beta = 0.046, t = 3.092, p = 0.002$). Because both direct and indirect paths are statistically established, Competitive Intensity acts as a significant partial mediator, leading to the rejection of H_{02}.

Table 5: Summary of Core Structural Paths and Hypotheses Decisions

Path Type	Structural Path	Path Coeff. (β)	T Stat	P Value	95% Confidence Interval	Decision / Conclusion
Direct Path (H_{01})	DI → CES	0.155	3.301	0.001	[0.058, 0.244]	H_{01} **Rejected** (Direct Effect)
Mediating Path	DI → CI	0.193	3.886	0.000	[0.098, 0.292]	Significant
Mediating Path	CI → CES	0.237	5.188	0.000	[0.148, 0.326]	Significant
Indirect Path (H_{02})	DI → CI → CES	0.046	3.092	0.002	[0.015, 0.076]	H_{02} **Rejected** (Partial Mediation)

Source: Author's Compilation via SmartPLS 4 (2026)

DISCUSSION OF FINDINGS

The findings of this research study give important understanding of the structural relationships between digital innovation, competitive intensity and customer effort score in North Central Nigeria commercial banking setting. First, Table 4 displays the explanatory capacity of the model: within digital innovation dimensions, the customer effort score is explained by 46.9% with another 36.7% in the case of competitive intensity, which reflect a moderate to high predictive power as recognized by Martínez de Miguel et al.,(2022), who found that digital capabilities are strong predictors of customer results (R^2=0.453). The explanations of the customer friction obtained in this study are consistent with others as Nwankwo et al., (2023), and Eke et al.,(2024) which proposed digital platforms encompass customer pain points-, and also sustain for other work which asserts that market competition is driven bythe action of investments in automation and digital connectivity.

Second, as for the direct path-relationships as seen in Table 5, Digital Innovation significantly improves the customer experience in reducing Customer Effort Scores (β=0.155,t=3.301,p=0.001) which, in turn, results in

the rejection of H_{01}. This indicates that digital channels, AI-enabled support, and mobile platforms alleviate substantially retail banking customers' operational, temporal, and cognitive friction in service delivery. The finding corroborates the earlier claims of Ameseguin and Olayemi (2025) and Nwankwo et al. (2023) that digital service innovations provide solutions to facilitate journey touchpoints in infrastructure or network conditions.

Third, the empirical results attest that market are important intervening variables. Digital innovation appreciably raises Competitive Intensity (β=0.193,t=3.886,p=0.000) and this, in turn, effectsed improvements in CES (β=0.237,t=5.188,p=0.000). Bootstrapping gives the indirect impact Digital Innovation on CES via Competitive Intensity as significant (β=0.046,t=3.092,p=0.002). So we conclude for this it is a case of both direct and indirect routes and this makes Competitive Intensity a more important partial mediator for our result in that leading to the rejection of hypothesis H_{02} (which is consistent with the Dynamic Capabilities Perspective (Teece, 2021) and Service-Dominant Logic (Vargo & Lusch, 2022) i.e. TEC adoption acts as an important trigger for competition as market forces posits the need for financial institutions to minimize user-interface flaws and eliminate service blockages to stay relevant to keep customers (Eke et al., 2024; Nnamdi & Eze, 2023).

CONCLUSION AND RECOMMENDATION

This study confirms the importance of digital innovation in directly improving customer effort in electronic banking by reducing the operational, temporal and cognitive friction that customers face. We also show that industry competition is not just an uninformative factor but an important partial mediator. In illustrating how digital innovation causes increased industry competition that compels banks to optimize user experiences and eliminate process bottlenecks, we contribute to the expansion of the Dynamic Capabilities Perspective and Service-Dominant Logic in the context of Sub-Saharan African emerging financial markets. In sum, under high competitive pressure, banks need to leverage their digital capabilities to minimize customer friction and retain them in the long run. Based on our empirical results, we suggest the following guidelines for bank managers, practitioners and policy makers:

1. Commercial bank executives should continuously upgrade digital banking architectures such as mobile apps and AI-driven support systems, focusing on interface simplification to persistently lower the Customer Effort Score.
2. Bank strategists must actively monitor regional market rivalries and FinTech disintermediation, utilising competitive pressure as an internal catalyst to drive continuous process re-engineering and faster dispute resolution.

LIMITATIONS AND DIRECTIONS FOR FURTHER STUDIES

This research has its weaknesses, which can be addressed in future studies. Firstly, the study was cross-sectional, and the data obtained were collected at a particular time; thus, causality cannot be established, and the behavior change of customer effort can be monitored using a longitudinal research design. Secondly, this research has geographical boundaries, as the data were collected from commercial bank customers in North Central Nigeria. Generalization of the results beyond the study environment is therefore constrained, especially to developing economies with different infrastructural facilities. Thirdly, the data collection method was a self-reporting questionnaire in which Digital Innovation, Competitive Intensity and Customer Effort Score were all reported by the same customers. Digital Innovation and Competitive Intensity are therefore perceptual measures and not objective bank-level or market-level indicators, and common method bias cannot be ruled out. Future studies could combine customer perceptions with objective indicators, such as bank technology investment or market concentration ratios.

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