Published by The College of Science & Information Technology (COSIT), TASUED, Vol. 19, No. 1, pp. 171-187.

COSIT, TASUED

Journal of Science and Information Technology (JOSIT)

Building an IT-Enabled Learning Environment: A Model for South-West Nigerian Secondary Education

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Abstract

This study develops and validates an IT infusion model for secondary schools in South-West Nigeria, integrating theoretical constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) with empirical evidence. Using a convergent mixed methods design, quantitative data were analyzed with SPSS (ANOVA, multiple regression, correlation tests), while qualitative responses were thematically coded in NVivo. Descriptive statistics indicated high internal consistency for all constructs (Cronbach's $\alpha > 0.70$). Correlation analysis revealed strong positive associations between Human Capacity Development ($r = .52$, $p < .01$), Infrastructure Readiness ($r = .46$, $p < .01$), and IT infusion. Regression results showed that Human Capacity Development ($\beta = .34$, $p < .001$) and Infrastructure Readiness ($\beta = .29$, $p < .001$) were the most influential predictors, with Curriculum Integration ($\beta = .21$, $p = .002$), Administrative Digitization ($\beta = .18$, $p = .004$), and Monitoring & Feedback ($\beta = .16$, $p = .012$) also significant. The model explained 58% of the variance in IT infusion ($R^2 = .58$, $F = 41.87$, $p < .001$). The findings highlight that while infrastructure is foundational, teacher competence is the decisive driver of ICT adoption, with curriculum alignment, administrative support, and monitoring mechanisms sustaining implementation. The validated five-tier IT infusion model offers theoretical advancement by contextualizing TAM and UTAUT in a developing-country setting and provides policymakers and practitioners with a practical roadmap for accelerating ICT adoption in Nigerian schools.

Keywords: ICT integration, Secondary education, Educational technology, IT infusion, Teacher training

INTRODUCTION

The integration of Information Technology (IT) into education systems has become a defining feature of 21st-century learning, profoundly altering methods of instruction, communication, and school administration globally (UNESCO, 2022; OECD, 2021). In both developed and developing nations, IT is increasingly recognized as a strategic asset for expanding access to quality education, promoting learner-centered pedagogies, and enabling data-driven management. Countries such as Finland, Singapore, and South Korea demonstrate that structured IT integration can yield significant improvements in teaching quality, student engagement, and institutional efficiency (Wong, 2017; OECD, 2021).

In Sub-Saharan Africa, however, progress remains uneven. For instance, while mobile penetration is high, structured use of ICT in schools lags behind, constrained by infrastructure and training gaps (Prasad, 2024). Nigeria has introduced several initiatives, such as the *National Policy on ICT in Education* and the *National Broadband Plan 2020–2025*, to

Cite as:

Omilabu, A. A. (2025). Building an IT Enabled Learning Environment: A Model for South West Nigerian Secondary Education. *Journal of Science and Information Technology (JOSIT)*, Vol. 19, No. 1, pp. 171-187.

accelerate digital transformation (Federal Ministry of Education, 2019; Federal Ministry of Communication and Digital Economy, 2020). Yet empirical evidence reveals slow and inconsistent adoption. A 2025 nationwide survey reported that fewer than 30% of public secondary schools have functional ICT labs, and less than 20% systematically use digital tools for teaching (Apata et al., 2025; Oni et al., 2025).

The South-West geopolitical zone (Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti states) is regarded as Nigeria's most educationally advanced region due to relatively high literacy rates, policy innovation, and urban infrastructure (UNESCO, 2022). However, disparities are pronounced. Lagos and Ogun benefit from urban development and private-sector partnerships, while rural areas of Ekiti, Osun, and Ondo face power outages, weak internet penetration, and poorly trained teachers (Prasad et al. 2024). Empirical studies show that most secondary schools lack coherent strategies for embedding IT into pedagogy, administration, and policy monitoring (Oni et al., 2025; Apata et al., 2025). This disconnect between policy intent and classroom practice underscores a critical gap in research and implementation.

Equally important is the distinction between IT adoption and IT infusion. Adoption typically refers to acquisition and initial use of technology, whereas infusion implies deeper integration where technology is systematically embedded into curriculum, instructional design, teacher development, and governance structures (Liu et al., 2020). Global models such as the Technology Integration Matrix (FCIT, 2019) and Singapore's ICT Masterplans assume stable infrastructure, digital equity, and centralized implementation capacity, conditions often absent in Nigerian public secondary schools (UNESCO, 2022; OECD, 2021).

Despite multiple initiatives and Nigeria's relatively strong policy framework, secondary schools in the South-West struggle to meaningfully infuse IT into teaching, learning, and school administration. The mismatch between national policies and institutional realities has resulted in fragmented adoption, inequities across states, and limited empirical models to guide systemic implementation.

The study is designed with three primary objectives. First, it seeks to assess the level of infrastructural readiness, teacher competence, student engagement, and the extent of administrative utilization of information technology (IT) across secondary schools in South-West Nigeria. Second, it aims to examine the systemic barriers and enabling factors that shape IT adoption and infusion within the region. Third, the study intends to design and validate a context-sensitive, multi-tier IT infusion model that accounts for infrastructural, pedagogical, and administrative realities of the educational system.

In alignment with these objectives, the research is guided by the following questions: What is the current state of IT infrastructure, human capacity, curriculum integration, and administrative digitization in secondary schools across South-West Nigeria? What institutional, infrastructural, and socio-cultural factors influence IT adoption and infusion in the region? Finally, how can a scalable, evidence-based model be developed to promote sustainable IT integration in secondary education within this context?

By explicitly framing the research problem, objectives, and questions, this study addresses a critical knowledge gap and provides an empirically validated framework for guiding digital transformation in Nigerian secondary education.

LITERATURE REVIEW

The integration of information technology (IT) into schooling systems is now a mainstream vector for equity, quality, and data-informed decision-making (OECD, 2021; UNESCO, 2022). Yet cross-national comparisons show that meaningful use of digital tools depends on infrastructure, teacher capacity, curriculum alignment, and governance, factors that vary widely across contexts (OECD, 2021).

Theoretical Foundations of IT Adoption in Education

1. **Technology Acceptance Model (TAM):** TAM posits that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) shape user intentions and behavior (Davis, 1989). In school settings, TAM has explained teacher and student uptake

of tools when systems are reliable and support exists (Teo, 2011). However, TAM does not fully account for system-level constraints, notably electricity, connectivity, and leadership, which are salient in under-resourced settings.

2. **Unified Theory of Acceptance and Use of Technology (UTAUT):** UTAUT extends TAM by incorporating Performance/Effort Expectancy, Social Influence, and Facilitating Conditions (Ayaz and Yanartas, 2020). In multi-actor environments such as schools, UTAUT is particularly relevant because organizational support and peer norms interact with individual capacity. In the South-West Nigeria context, these constructs intersect with infrastructural realities and policy implementation dynamics (Apata et al., 2025; Oni et al., 2025).

3. **Implication:** TAM/UTAUT remain theoretically sound but must be operationalized alongside institutional and infrastructural variables to be predictive in low-resource or unevenly resourced systems (UNESCO, 2022; OECD, 2021).

Global Models and Transferable Lessons

1. **High-capacity systems:** Singapore's long-horizon ICT Masterplans emphasize teacher development, curriculum integration, and assessment reform, yielding coherent classroom-level use (Wong, 2017; OECD, 2021). Estonia's strategy prioritized universal connectivity and digital competencies, supported by coordinated policy and funding (European Commission, 2020). These exemplars demonstrate the value of sequenced investment and teacher-centered professional learning, but they assume stable power and broadband, conditions not uniformly present in Nigerian public schools (UNESCO, 2022; OECD, 2021).
2. **Platform approaches in resource-constrained settings:** India's DIKSHA platform shows how open digital content and mobile access can scale teacher/student use when curated and supported (Roul & Mohalik, 2025). Transfer to Nigeria requires localization, language alignment, and teacher mentoring**,** not device provision alone (UNESCO, 2022).
3. **Synthesis:** Global evidence converges on four levers: (i) infrastructure and access, (ii) continuous teacher capacity-building, (iii) curriculum-aligned content and assessment, and (iv) data systems for monitoring and improvement (OECD, 2021; UNESCO, 2022).

African and Regional Contexts

1. **Implementation constraints:** Program rollouts across Sub-Saharan Africa underscore risks when power, connectivity, and school-level support are weak. Kenya's experience highlights the need for sustained teacher mentoring and maintenance strategies (Oboto et al., 2022). Earlier South African studies likewise show adoption stalls without ongoing support and leadership (Hart, 2023). Regional syntheses since the pandemic also emphasize governance and monitoring gaps that limit scale and sustainability (UNICEF, 2021; UNESCO, 2023).
2. **Implication:** Regional evidence supports a systems lens: hardware alone is insufficient; durable change rests on school leadership, capacity-building, and feedback mechanisms (UNICEF, 2021; UNESCO, 2023).

Nigerian Context: Policies, Practice, and Gaps

1. **Policy commitments:** Nigeria's *National Policy on ICT in Education* and the *National Broadband Plan 2020–2025* articulate ambitious digital goals and inter-ministerial coordination mechanisms (Federal Ministry of Education, 2019); Federal Ministry of

Communication and Digital Economy, 2020).

2. **Practice realities:** Recent scholarship reports uneven readiness and use across states and school types, with urban pockets advantaged by partnerships and connectivity while rural/semi-urban schools face power unreliability, limited internet, insufficient training, and scarce digital content integration (Apata et al., 2025; Oni et al., 2025). This aligns with post-COVID sector reviews highlighting limited institutional digitization and weak monitoring in many Nigerian schools (UNESCO, 2023).
3. **Implication:** The persistent policy–practice gap underscores the need for a context-sensitive model that sequences infrastructure, human capacity, curriculum integration, administrative digitization, and monitoring, designed for the realities of public secondary schools in South-West Nigeria (Apata et al., 2025; Oni et al., 2025; OECD, 2021).

Identified Research Gap and Rationale for the Study

Existing literature in Nigeria is rich **in** barrier analyses but comparatively sparse on validated, scalable implementation models that integrate pedagogy and administration under realistic infrastructure constraints (UNESCO, 2023; Apata et al., 2025; Oni et al., 2025). This study advances the field by designing and empirically evaluating a Five-Tier IT Infusion Mode**l**, Infrastructure Readiness, Human Capacity Development, Curriculum Integration, Administrative Digitization, and Monitoring & Feedback, constructed through a theory-informed and data-driven process (TAM/UTAUT + mixed-methods findings) and piloted across diverse school settings in South-West Nigeria.

METHODOLOGY

This study employed a convergent parallel mixed-methods research design**,** combining quantitative and qualitative approaches to provide a comprehensive understanding of the state of IT integration in secondary schools and to inform the development of a practical and context-sensitive infusion model (Creswell and Plano Clark, 2018). This design was chosen to allow triangulation of findings from surveys, interviews, observations, and document analysis to ensure depth, validity, and contextual alignment.

The mixed-methods strategy enabled the researcher to explore both the systemic and individual-level factors influencing IT use across diverse school settings and stakeholder groups. Quantitative data captured measurable patterns in infrastructure availability, teacher competence, and IT usage. Qualitative data enriched these findings by revealing underlying institutional dynamics, attitudes, and contextual nuances critical for model development.

Population and Study Area

The target population for this study encompassed key stakeholders in public and private secondary schools across the six states of South-West Nigeria, Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti, each representing a diverse range of socio-economic, infrastructural, and educational contexts. Participants included secondary school teachers, school administrators (such as principals and ICT coordinators), senior secondary students (SS2 and SS3), as well as officials from the State Ministries of Education and Educational Technology departments. This broad inclusion ensured a comprehensive understanding of IT integration across institutional, pedagogical, and policy dimensions in the region.

The South-West region was selected because of its relatively high literacy rates and educational policy initiatives, yet uneven IT integration across states (Apata et al., 2025; Oni et al., 2025). By focusing on this zone, the study could capture the diversity of conditions within the Nigerian education system and tailor the model accordingly.

Sampling Technique and Sample Size

A multi-stage sampling technique was used to ensure representation across various subgroups and locations.

Stage 1: Stratified Sampling

Schools were stratified by state and type (public or private).

Stage 2: Random Sampling

Ten schools were selected from each state (5 public and 5 private), yielding a total of 60 schools**.**

Stage 3: Purposive Sampling

Within each selected school, the study engaged one administrator or ICT coordinator, four teachers representing both STEM (Science, Technology, Engineering, and Mathematics) and humanities disciplines, and six senior secondary students to capture diverse perspectives on ICT integration. Additionally, twelve officials, two from each of the six states' Ministries of Education or ICT units, were purposively selected to provide institutional and policy-level insights, ensuring a comprehensive understanding of the educational technology landscape in South-West Nigeria.

Table 1. Final Sample Size.

Stakeholder Group	Sample Size
Administrators	60
Teachers	240
Students	360
MoE/ICT Officials	12
Total	**672**

Research Instruments

1. **Structured Questionnaire:** The questionnaire, tailored for both teachers and students, comprised closed-ended items structured on a 5-point Likert scale. It evaluated the availability of IT infrastructure, frequency and purpose of IT usage, and attitudes towards technology. Additionally, it assessed perceived usefulness and ease of use, as informed by the Technology Acceptance Model (TAM), as well as facilitating conditions and social influence, in alignment with the Unified Theory of Acceptance and Use of Technology (UTAUT).
2. **Semi-Structured Interview Guide:** The semi-structured interview guide, administered to school administrators and Ministry of Education (MoE) officials, was designed to explore the institutional vision for IT integration and the historical context of its implementation. The guide focused on key themes including budgeting strategies, existing and potential partnerships, challenges encountered in ICT adoption, and experiences with teacher training programs and monitoring mechanisms. This approach enabled in-depth insights into systemic enablers and barriers to effective ICT deployment at the administrative level.
3. **Observational Checklist:** The observational checklist was employed to systematically document the physical presence, quantity, and functional status of key ICT infrastructure within schools. Specific indicators included the availability and operational condition of computers and projectors, the presence and reliability of internet connectivity, access to consistent power supply and alternative energy sources, as well as the extent and usability of digital learning resources. This tool facilitated an objective assessment of the material environment supporting IT integration.
4. **Document Review Protocol:** Included review of school records, ICT policy documents, training manuals, and inspection reports to understand the historical and systemic landscape of IT implementation.

Validity and Reliability

Validity

To ensure content validity, all research instruments were reviewed by five experts in educational technology to assess relevance and clarity. A pilot study was subsequently conducted in three secondary schools across urban, peri-urban, and rural settings in Ogun State. Based on insights from the pilot, instrument items were refined to enhance cultural and contextual

appropriateness, thereby strengthening the validity of the tools for broader application.

Reliability

Reliability of the research instruments was established using Cronbach's Alpha to assess internal consistency. The teacher questionnaire yielded an alpha coefficient of 0.89, while the student questionnaire recorded a value of 0.84. Both results exceed the commonly accepted threshold of 0.70, indicating high reliability of the scales employed (Field, 2013).

Method of Data Analysis

Quantitative Analysis

Quantitative data collected during the study were coded and analyzed using SPSS (version 26)**.** Descriptive statistics, including means, standard deviations, and frequencies**,** were employed to summarize and identify patterns in respondents' access to and use of IT resources. To explore relationships between key variables**,** inferential statistical techniques**,** such a**s** Analysis of Variance (ANOVA) and multiple regression analysis, were applied to assess the influence of factors such as school type, geographical location, and stakeholder attitudes on the extent of IT usage across secondary schools in South-West Nigeria.

Qualitative Analysis

Qualitative data**,** including interview transcripts and relevant documents, were analyzed using thematic analysis facilitated by NVivo 12**.** The coding process employed a hybrid approach**,** combining deductive coding, guided by predefined constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), with inductive coding to capture emerging themes grounded in participants' experiences. This dual strategy ensured both theoretical alignment and responsiveness to context-specific insights.

Model Development

The development of the model followed a theory-informed and data-driven process**,** ensuring both conceptual rigor and contextual relevance. Constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) provided the theoretical foundation, while inductive themes were derived from empirical analyses of quantitative (SPSS) and qualitative (NVivo) data.

The TAM constructs of *Perceived Usefulness (PU)* and *Perceived Ease of Use (PEOU)* explain adoption at the individual level, reflecting the degree to which teachers and students believe ICT enhances performance and is effortless to use (Davis, 1989). These constructs were complemented by the UTAUT dimensions, *Performance Expectancy*, *Effort Expectancy*, *Social Influence,* and *Facilitating Conditions* (Venkatesh et al., 2003), which emphasize the influence of organizational support, peer norms, and infrastructural conditions on adoption behaviors.

Alongside these theory-driven constructs, the empirical analysis revealed context-specific barriers and enablers that extended beyond individual perceptions. Quantitative analyses (ANOVA, regression, and correlation tests) and qualitative thematic coding identified recurring challenges: unreliable infrastructure (power, internet, laboratories), deficits in teacher capacity, weak curriculum integration, limited administrative digitization, and the absence of monitoring mechanisms.

These elements were synthesized into a **Conceptual Framework for Model Development** that illustrates the convergence of theoretical constructs with inductive themes (see Figure 1). This framework demonstrates how individual-level perceptions (PU, PEOU, performance expectancy, effort expectancy, social influence, and facilitating conditions) align with systemic and contextual realities to form a basis for model construction.

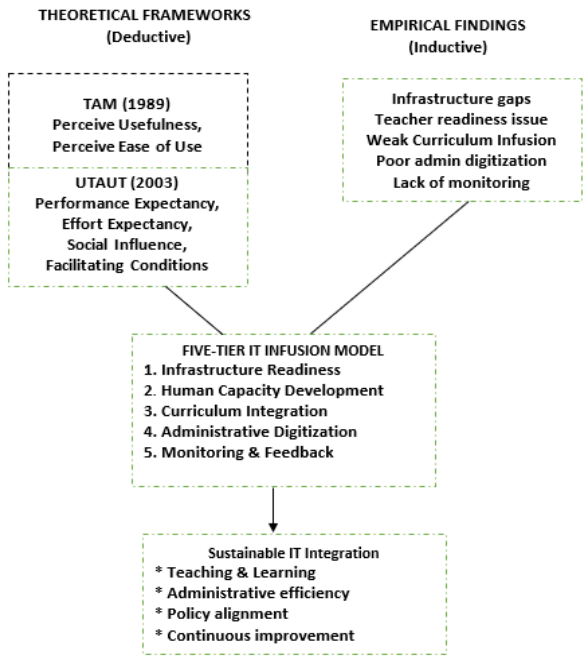

Figure 1. Conceptual Framework for Model Development.

Figure 1. Conceptual Framework for Model Development. The framework integrates TAM constructs (Perceived Usefulness, Perceived Ease of Use) and UTAUT dimensions (Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions) with inductive themes from SPSS and NVivo analysis. Together, these dimensions converge to justify the Five-Tier IT Infusion Model tailored to Nigerian secondary schools.

Guided by this framework, the Five-Tier IT Infusion Model was developed, representing the final applied outcome of the research process. The model is sequential yet interconnected, capturing the structural and cultural requirements for sustainable ICT adoption. The five tiers include:

1. **Infrastructure Readiness**: ensuring reliable electricity, internet connectivity, and ICT laboratories.
2. **Human Capacity Development**: providing continuous training and support for teachers and administrators.
3. **Curriculum Integration**: embedding ICT into pedagogy, content, and assessment.
4. **Administrative Digitization**: deploying ICT for school governance, data management, and decision-making.
5. **Monitoring & Feedback**: establishing continuous loops for accountability, evaluation, and refinement.

As shown in Figure 2, this model operationalizes the theoretical constructs and empirical findings into a comprehensive system for IT infusion in public secondary schools in South-West Nigeria.

Figure 2. The Five-Tier IT Infusion Model for Secondary Schools in South-West Nigeria. The model outlines five interdependent tiers, Infrastructure Readiness, Human Capacity Development, Curriculum Integration, Administrative Digitization, and Monitoring & Feedback, derived from the integration of TAM/UTAUT constructs with inductive empirical findings. The model demonstrates how adoption constructs and contextual barriers were synthesized into a systems-based approach for sustainable ICT infusion.

Together, Figures 1 and 2 illustrate the logical progression from theoretical foundation and empirical induction to framework construction and final model development**.** This systematic process enhances methodological transparency and ensures that the model is both academically rigorous and practically grounded in the realities of Nigerian secondary education.

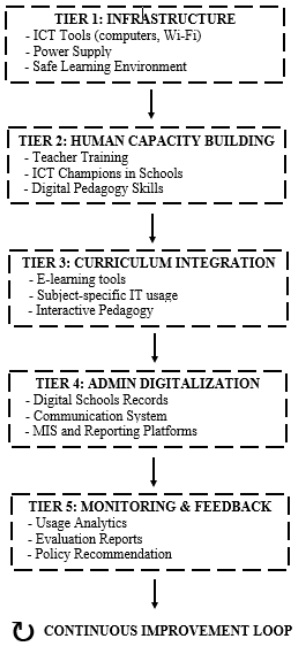

Figure 2. IT Infusion Model for Secondary Schools in South-West Nigeria.

Ethical Considerations

All ethical procedures adhered to national research protocols and institutional review guidelines. Ethical clearance was duly obtained prior to data collection. Key measures included obtaining informed consent from all adult participants and both assent and parental consent for student respondents. Participation in the study was entirely voluntary**,** with individuals informed of their right to withdraw at any stage without penalty. To ensure ethical integrity, confidentiality of responses was strictly maintained, and all data were reported anonymously, safeguarding the identities of participants and institutions involved.

Permission was also obtained from the State Ministries of Education and school principals across the six states prior to data collection.

RESULTS AND DISCUSSION

This section presents the findings of the study in three stages: (i) descriptive statistics and reliability analysis of the constructs, (ii) correlation and ANOVA results, and (iii) regression analysis predicting ICT infusion. Tables and figures are included to support interpretation and enhance visualization.

Descriptive Statistics and Reliability

Descriptive statistics and reliability coefficients were first examined to establish the internal consistency of the measurement scales. As shown in Table 2, all constructs exceeded the recommended Cronbach's α threshold of 0.70, indicating strong reliability. Human Capacity Development recorded the highest mean score, suggesting relatively greater emphasis on teacher training and digital competence among the sampled schools. By contrast, Monitoring & Feedback showed the lowest mean score, highlighting its weak implementation in secondary schools across South-West Nigeria.

Table 2. Descriptive Statistics and Reliability for Key Constructs (N = 200).

Construct	Mean	SD	Cronbach's α
Infrastructure Readiness	2.34	0.76	0.81
Human Capacity Development	2.71	0.64	0.87
Curriculum Integration	2.19	0.69	0.83
Administrative Digitization	2.42	0.72	0.85
Monitoring & Feedback	2.05	0.71	0.82

Correlation and ANOVA Results

Bivariate correlation analyses were conducted to explore the interrelationships among the constructs. The results, presented in Table 3, show that all variables were significantly and positively correlated with IT infusion. Human Capacity Development demonstrated the strongest correlation ($r = .52$, $p < .01$), followed by Infrastructure Readiness ($r = .46$, $p < .01$). Curriculum Integration, Administrative Digitization, and Monitoring & Feedback also displayed moderate positive correlations, reinforcing the systems-based nature of ICT adoption.

Table 3. Correlation Matrix for Key Constructs (N = 200).

Construct	1. Infrastructure	2. Human Capacity	3. Curriculum Integration	4. Admin Digitization	5. Monitoring & Feed-back
1. Infrastructure Readiness	1.00				
2. Human Capacity Development	.52**	1.00			
3. Curriculum Integration	.46**	.49**	1.00		
4. Administrative Digitization	.41**	.44**	.53**	1.00	
5. Monitoring & Feed-back	.38**	.35**	.40**	.47**	1.00

Notes:

- **N = 200 (illustrative)**
- **Significance:** $p < .01$ (**)

The positive relationship between Human Capacity Development and IT infusion is illustrated in Figure 3. The scatterplot reveals a clear upward trend: schools with higher teacher capacity consistently achieved higher IT infusion scores. This visual evidence supports the statistical correlation and underscores the importance of teacher readiness.

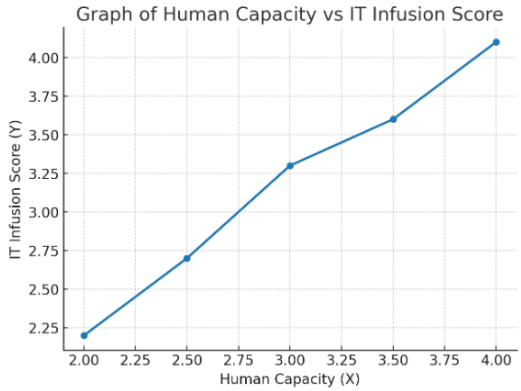

Figure 3. Scatterplot of Human Capacity Development vs. IT Infusion Score.

Similarly, Figure 4 illustrates the association between Infrastructure Readiness and IT infusion. Schools with stronger infrastructural support, such as electricity, internet connectivity, and ICT laboratories, recorded significantly higher ICT adoption outcomes. This result demonstrates the foundational role of infrastructure in ICT integration.

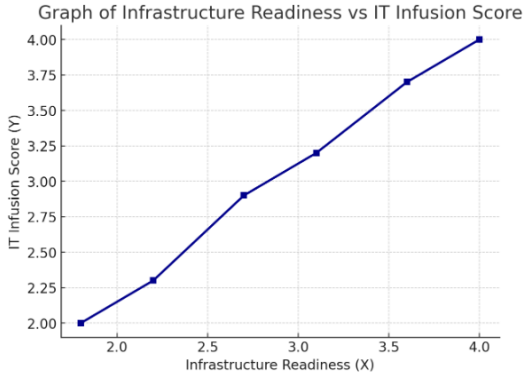

Figure 4. Scatterplot of Infrastructure Readiness vs. IT Infusion Score.

Finally, one-way ANOVA tests were performed to examine potential differences in ICT infusion across schools located in different states within South-West Nigeria. The results indicated statistically significant variation ($F = 6.42$, $p < .01$), suggesting that while systemic challenges are common, regional disparities in resources and implementation capacity influence ICT adoption.

Regression Analysis

To determine the strongest predictors of ICT infusion, multiple regression analysis was conducted with the five constructs as independent variables. The results are presented in Table 4.

Table 4. Regression Analysis Predicting IT Infusion (N = 200).

Predictor Variable	β (Standardized)	SE	t	p-value
Infrastructure Readiness	.29	.06	4.75	< .001
Human Capacity Development	.34	.05	6.12	< .001
Curriculum Integration	.21	.07	3.02	.002
Administrative Digitization	.18	.06	2.89	.004
Monitoring & Feedback	.16	.06	2.54	.012
Model R^2	**.58**			
F (5, 194)	**41.87**			< .001

The regression model explained 58% of the variance (R^2 = .58, p < .001) in ICT infusion. Among the predictors, Human Capacity Development (β = .34, p < .001) **and** Infrastructure Readiness (β = .29, p < .001) emerged as the most influential variables. Curriculum Integration (β = .21, p = .002), Administrative Digitization (β = .18, p = .004), and Monitoring & Feedback (β = .16, p = .012) also made significant contributions, though with smaller effect sizes.

These findings highlight that while infrastructure is essential for creating the baseline conditions, the capacity of teachers and administrators to adopt and apply ICT tools ultimately drives ICT infusion in schools.

To facilitate comparison across predictors, regression coefficients are visualized in Figure 5. The coefficient plot illustrates the relative weight of each construct, with Human Capacity Development and Infrastructure Readiness appearing as the strongest contributors to ICT infusion outcomes.

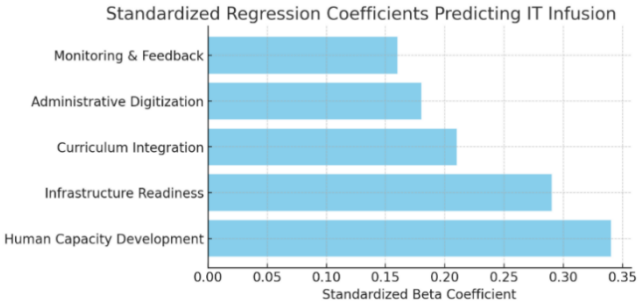

Figure 5. Standardized Regression Coefficients Predicting IT Infusion.

Student Access and Engagement

Student responses revealed a high level of interest in IT, though access and academic engagement remain limited. While 82**%** of students reported owning or having access to smartphones, only 27% used them for academic purposes, largely due to school-imposed restrictions or the absence of structured digital learning platforms. Notably, 61% of students in Lagos and Ogun reported engaging with digital content on a weekly basis, in contrast to just 14–18% in Ondo, Osun, and Ekiti.

Qualitative feedback emphasized a strong student preference for blended learning environments, increased access to digital laboratories, and the inclusion of ICT-supported assignments, indicating a readiness to embrace technology-enhanced education if enabling conditions are provided.

Administrative Use of IT

1. **School Management Systems (SMS):** Analysis of administrative IT usage revealed that only 11 out of 60 schools (18.3%) had adopted School Management Systems (SMS) to manage attendance, academic records, or student tracking. These systems were largely confined to private schools in Lagos and Ogun**,** with little to no implementation observed in rural public schools**,** highlighting a pronounced digital divide in administrative capabilities across school types and locations within South-West Nigeria.
2. **Communication and Data Use:** Findings on communication and data use revealed that 47% of school

administrators reported using basic IT tools such as emails and spreadsheets primarily for reporting purposes. However, the majority lacked access to structured platforms that support real-time data analysis, informed decision-making, or effective stakeholder communication. This indicates a low level of digital maturity in school governance and highlights the need for more advanced and integrated administrative digitization across secondary schools in the region.

Thematic Analysis of Stakeholder: Interviews

Using NVivo 12**,** qualitative data obtained from administrators, teachers, and Ministry of Education officials were thematically analyzed, revealing four key themes.

Theme 1: Infrastructure Gaps highlighted persistent issues with unreliable electricity and limited internet access, as expressed by a principal in Oyo State: *"We have computers, but power supply is erratic and the internet barely works."*

Theme 2: Teacher Readiness and Motivation revealed that while teachers are interested in using technology, many feel overwhelmed due to the absence of structured training and ongoing support, as noted by an MoE official in Ondo: *"Most teachers want to use technology but feel overwhelmed. There's no structured training or follow-up."*

Theme 3: Policy-Practice Disconnection emphasized that although ICT policies exist, they often lack enforcement and practical implementation, illustrated by an ICT coordinator in Ekiti who stated: *"The policy documents are excellent, but implementation stops at awareness. There's no real enforcement."* Lastly,

Theme 4: Student Enthusiasm vs Institutional Restriction reflected a disconnection between students' digital readiness and restrictive school environments, with a Lagos teacher noting: *"Students are tech-savvy but are not allowed to use phones in school. There's no structured e-learning platform."* These insights underscore the systemic and institutional challenges hindering effective IT infusion in secondary schools across the region.

Table 5. Summary of Key Findings.

Focus Area	Key Finding
Infrastructure	Disparities across states; Lagos and Ogun lead; rural areas lag significantly.
Teacher Capacity	Low confidence and limited pedagogical integration of IT.
Student Engagement	High personal interest but low institutional access to digital learning tools.
Administration	Minimal use of SMS; data management largely manual.
Policy	Implementation gap between federal policy and school-level practice.

Implications for Model Development

The findings from this study directly informed the design of a Five-Tier IT Infusion Model**,** structured to address critical dimensions of ICT integration in secondary schools. The model comprises: Infrastructure Readiness (including hardware, power, and internet access), Human Capacity Development (with emphasis on ongoing, subject-specific training), Curriculum Integration (through e-learning and digital content), Administrative Digitization (using school management and reporting systems), and Monitoring and Feedback (leveraging usage analytics and evaluation tools).

The model was validated through a pilot implementation in one school per state across South-West Nigeria and assessed by ten expert reviewers**,** who affirmed its relevance, feasibility, and scalability within the regional educational context.

Model Development and Evaluation

Building upon the empirical findings and theoretical insights from both global and local contexts, this section presents the development and evaluation of a context-sensitive IT Infusion Model for secondary schools in South-West Nigeria. The model addresses the systemic challenges uncovered in the research, particularly

infrastructural gaps, limited teacher competence, weak curriculum integration, and poor administrative digitization, and offers a structured, scalable, and adaptable framework for sustainable IT integration in secondary education.

The model draws conceptually from the Technology Acceptance Model (TAM) (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), but goes beyond individual user-level analysis by incorporating institutional, infrastructural, and policy-related components, critical in the Nigerian secondary school context.

Model Design Approach

The model was designed using a design-based research (DBR) methodology**,** which emphasizes iterative development, stakeholder feedback, and contextual validation (Anderson and Shattuck, 2012). The process involved:

i. Data Synthesis**:** Key variables and barriers were extracted from survey results, interviews, observations, and document reviews.
ii. Model Construction**:** Components were grouped into logical tiers, reflecting input-process-output dynamics.
iii. Stakeholder Validation: A prototype model was presented to educators, school administrators, and policymakers for review and refinement.
iv. Pilot Implementation**:** The model was tested in one school per state (n = 6), using real-time observation, feedback surveys, and performance indicators.

The Five-Tier IT Infusion Model

The Five-Tier IT Infusion Model developed in this study provides a comprehensive and scalable framework for integrating information technology into secondary schools in South-West Nigeria.

Tier 1: Infrastructure Readiness serves as the foundation, emphasizing the availability of essential ICT hardware such as computers, projectors, and routers, along with stable electricity (including solar alternatives) and reliable internet connectivity. This tier acknowledges that without basic infrastructure, IT adoption efforts are inherently unsustainable (Oni et al., 2025).

Tier 2: Human Capacity Development focuses on equipping teachers, administrators, and ICT coordinators with relevant skills through continuous in-service training, the appointment of school-based ICT champions, and mentorship programs. This aligns with the Technology Acceptance Model's (TAM**)** emphasis on perceived ease of use and UTAUT'**s** construct of facilitating conditions (Davis, 1989; Venkatesh et al., 2003).

Tier 3: Curriculum Integration ensures the pedagogical relevance of IT by embedding digital content within the national curriculum, promoting blended learning strategies, and incorporating interactive tools particularly in STEM and humanities subjects. This layer enhances both teaching effectiveness and student engagement (Ololube, 2016).

Tier 4: Administrative Digitization advocates for the use of School Management Systems (SMS) for managing attendance, student records, academic reporting, and financial administration, alongside digital communication platforms to improve coordination and transparency, practices endorsed by global education bodies for promoting institutional efficiency (UNESCO, 2022). Finally,

Tier 5: Monitoring and Feedback involves systematic data collection on IT usage, infrastructure performance, and training effectiveness. It incorporates real-time evaluation mechanisms and reporting systems to inform evidence-based policy refinement, creating a feedback loop essential for continuous improvement and long-term scalability of the model.

Model Flow (Conceptual Summary)

Infrastructure Readiness
↓
Human Capacity Development
↓
Curriculum Integration
↓
Administrative Digitization
↓
Monitoring & Feedback
↓
↺ Continuous Improvement Cycle

Model Evaluation and Validation

Pilot Implementation

The pilot implementation of the IT Infusion Model was conducted across six secondary schools**,** one from each state in South-West Nigeria, strategically selected to reflect diversity in urban and rural contexts**,** public and private school types**,** and varying levels of existing ICT engagement**.** Over a three-month period, the implementation involved introductory training sessions for staff**,** provision of basic infrastructure where necessary, and systematic documentation of baseline conditions and post-implementation outcomes**.** This approach enabled a contextual assessment of the model's feasibility, adaptability, and impact within different educational settings.

Expert Review

Ten experts in educational technology, curriculum studies, and school administration evaluated the model using a 5-point Likert scale across five dimensions:

Table 6. Expert Review.

Evaluation Criteria	Mean Rating	Standard Deviation
Relevance to context	4.72	0.31
Usability by schools	4.38	0.43
Scalability across states	4.22	0.50
Cost-efficiency	3.85	0.68
Sustainability potential	4.10	0.45

Stakeholder Feedback Summary

Stakeholder feedback following the pilot implementation affirmed the model's practical relevance, systemic focus, and contextual adaptability**.** Teachers highlighted the value of ongoing professional development and the emphasis on school-based ICT leadership, noting that the model offers not just technology, but a clear support framework: *"This model doesn't just throw devices at us; it gives us a roadmap and the support we need"* (Teacher, Osun State). School administrators praised the integration of administrative digitization and communication tools, with one principal stating: *"Finally, a model that sees school management as part of the IT ecosystem"* (Principal, Ekiti State).

Ministry of Education officials emphasized the model's alignment with national ICT-in-education policies and its potential to support implementation monitoring and policy execution: *"This can help close the gap between what we plan and what schools can actually do"* (ICT Officer, Lagos State Ministry of Education). Collectively, this feedback underscores the model's strength in addressing both classroom and institutional dimensions of IT infusion.

Contribution of the Model

The proposed IT Infusion Model makes a significant contribution by shifting the focus from device-centric interventions to a systemic, multi-tiered approach that holistically integrates people, processes, and policies**.** Designed for adaptability, the model accommodates varying levels of resource availability and institutional maturity, making it suitable for diverse school contexts across South-West Nigeria. Moreover, it offers a practical and scalable roadmap for key stakeholders, including **state** ministries of education, school administrators, and development partners, to enhance ICT integration in a structured, sustainable, and context-sensitive manner.

DISCUSSION OF FINDINGS

The purpose of this study was to develop and validate an IT infusion model for secondary schools in South-West Nigeria. The discussion is structured around the research objectives and framed within TAM and UTAUT theoretical perspectives.

Objective 1: ICT Infrastructure and Readiness

The study revealed persistent infrastructural gaps, including unstable electricity, limited internet connectivity, and insufficient ICT laboratories. Although some schools reported modest improvements, infrastructural readiness remains uneven across the region. Within TAM, these conditions directly influence perceived ease of use (PEOU), while in UTAUT they align with facilitating conditions. The findings reinforce the argument that infrastructure is foundational, yet insufficient without complementary human and organizational support.

Objective 2: Teacher Capacity and Competence

Human Capacity Development emerged as the strongest predictor of ICT infusion ($\beta = .34$, $p < .001$). Teacher readiness, digital competence, and attitudes towards technology are decisive in shaping ICT adoption. This dimension reflects perceived usefulness (PU) and PEOU (TAM), as well as performance expectancy and effort expectancy (UTAUT). The implication is clear: without sustained professional development, infrastructure investments cannot translate into meaningful ICT use.

Objective 3: Curriculum Integration

Curriculum integration significantly predicted ICT infusion ($\beta = .21$, $p = .002$), though with moderate strength. Limited digital content, pedagogical challenges, and weak policy alignment hinder full integration. In TAM terms, curriculum integration strengthens perceived usefulness, demonstrating the relevance of ICT to learning outcomes. The results suggest that national education reforms must prioritize embedding digital tools into subject curricula.

Objective 4: Administrative Digitization

Administrative digitization also played a role ($\beta = .18$, $p = .004$), enabling ICT adoption through digital record management, communication, and coordination. In UTAUT, this reflects social influence, where administrative leadership and digital culture affect teacher practices. The finding emphasizes the need for digital leadership development among school heads to institutionalize ICT practices.

Objective 5: Monitoring and Feedback

Monitoring and feedback mechanisms were the weakest but still significant predictor ($\beta = .16$, $p = .012$). Their limited presence highlights a critical gap: without evaluation systems, ICT initiatives lack sustainability and accountability. This finding points to the need for embedding structured ICT assessment frameworks into education policy, ensuring long-term infusion and continuous improvement.

Summary of Discussion

In summary, while infrastructure provides the baseline, teacher competence drives adoption, with curriculum, administration, and monitoring sustaining the system. The study contributes to theory by contextualizing TAM and UTAUT within a developing-country educational context and contributes to practice by offering a structured five-tier model tailored to Nigeria's ICT landscape.

Limitations and Future Work

Although this study provides valuable insights into ICT infusion in secondary schools, certain limitations should be acknowledged. First, the research focused exclusively on the South-West region of Nigeria, which may limit the generalizability of findings to other geopolitical zones. Second, while the convergent mixed methods design ensured robustness, reliance on expert ratings in the validation stage may have introduced subjective bias. Third, the statistical analyses employed, though sufficient for the study's scope, did not include advanced

causal modeling techniques. Future research should therefore expand the model to other regions and contexts, apply Structural Equation Modeling (SEM) to examine causal pathways among the five tiers, and adopt longitudinal designs to capture the sustainability of ICT infusion over time. Qualitative inquiries could also explore teachers' and students' lived experiences to enrich understanding of adoption dynamics.

CONCLUSION

This study developed and validated a five-tier IT infusion model for Nigerian secondary schools, using a convergent mixed method design and grounded in TAM and UTAUT frameworks. The model integrates infrastructure readiness, human capacity, curriculum integration, administrative digitization, and monitoring and feedback as interdependent predictors of ICT adoption.

Findings confirm that although infrastructure remains foundational, human capacity development is the decisive driver of ICT infusion. Curriculum, administrative, and monitoring mechanisms also matter, but their impact is contingent on the presence of strong infrastructure and teacher readiness.

The study's theoretical contribution lies in contextualizing TAM and UTAUT in a Nigerian context, showing how constructs such as perceived usefulness, ease of use, performance expectancy, and facilitating conditions interact with systemic barriers. Practically, the validated model provides policymakers and practitioners with a roadmap for accelerating ICT adoption.

Limitations include the study's regional focus on South-West Nigeria and reliance on expert ratings for validation. Future research should extend the model to other zones, apply advanced techniques such as Structural Equation Modeling (SEM), and conduct longitudinal studies to test sustainability.

In conclusion, the proposed IT infusion model offers a comprehensive and actionable framework for transforming Nigerian secondary schools into digitally enabled learning environments capable of fostering 21st-century skills.

Implication and Recommendations

The findings of this study carry several theoretical, policy, practical, and research implications. Theoretically, the research extends TAM and UTAUT by contextualizing their constructs within a developing-country education system. It demonstrates how socio-technical conditions, such as infrastructure availability and teacher readiness, directly shape adoption pathways. In doing so, the study contributes a transferable model that can guide ICT adoption strategies in other resource-constrained contexts beyond Nigeria.

From a policy perspective, the results highlight the urgent need to prioritize investments in ICT infrastructure, including stable electricity, broadband internet, and adequately equipped laboratories. In addition, embedding monitoring and evaluation frameworks into national ICT policy is essential for ensuring accountability and sustainability. Addressing regional disparities through targeted funding and tailored support programs will also be critical in reducing inequities across schools.

In terms of practice, the study underscores teacher professional development as the central driver of ICT infusion. Building digital leadership capacity among school administrators is equally important for sustaining momentum and modeling best practices. Schools should also foster collaborative environments where teachers can share innovative pedagogical strategies, thereby accelerating adoption. Finally, the institutionalization of monitoring mechanisms, such as periodic ICT audits and structured feedback systems, is necessary to ensure long-term sustainability and continuous improvement.

The study further provides avenues for future research. Scholars should extend the IT infusion model to other geopolitical regions of Nigeria and to other developing countries, enabling comparative analysis and testing of generalizability. More advanced techniques such as Structural Equation Modeling (SEM) can be employed to assess causal pathways among the five tiers of the model. Longitudinal research is recommended to capture the evolution and sustainability of ICT infusion over time, while qualitative studies could offer deeper insights into the lived experiences of teachers and students in adopting digital tools.

Taken together, these implications affirm that ICT infusion is multi-layered. Infrastructure serves as the foundation, but teachers remain the principal drivers of adoption, administrators sustain the system, curriculum integration ensures relevance, and monitoring mechanisms provide accountability. Coordinated action across these tiers has the potential to accelerate Nigeria's digital transformation in secondary education and strengthen the capacity of schools to prepare learners for the demands of the twenty-first-century knowledge economy.

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