

Adoption of Emerging Technologies for Knowledge Management in Academic Libraries in North-East Nigeria

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The adoption of emerging technologies for knowledge management (KM) in academic libraries presents significant opportunities for enhancing information organisation, dissemination, and institutional memory preservation, particularly in resource-constrained regions such as North-East Nigeria. This study investigated the adoption of emerging technologies for knowledge management in academic libraries in the North-East geopolitical zone of Nigeria. A descriptive survey design was employed, targeting 389 library professionals across 18 academic libraries (universities, polytechnics, and colleges of education) in the six states of the zone. Data were collected using a structured questionnaire (Cronbach's $\alpha = 0.88$) and analysed using SPSS version 29 for descriptive statistics and one-way ANOVA, and SmartPLS version 4 for PLS-SEM path modelling. Python 3.11 generated supplementary visualisations. Findings indicated moderate overall technology adoption (Grand Mean = 3.72), with cloud computing (Mean = 4.38) and digital repository systems (Mean = 4.21) as the most adopted technologies. Knowledge management benefits were highly perceived (Grand Mean = 4.32), while barriers were equally prevalent (Grand Mean = 4.37), with poor ICT infrastructure (Mean = 4.63) and inadequate funding (Mean = 4.58) as the foremost impediments. SmartPLS SEM confirmed that technology readiness significantly predicted ET adoption ($\beta = 0.623$, $t = 13.84$, $p < 0.001$), which in turn predicted KM effectiveness ($\beta = 0.587$, $p < 0.001$). One-way ANOVA revealed significant adoption differences by designation ($F(3,385) = 21.38$, $p < .001$). The study recommends technology readiness programmes, institutional KM policy formulation, and consortium-based infrastructure investment.

Keywords: *Emerging Technologies, Knowledge Management, Academic Libraries, North-East Nigeria, SmartPLS, Cloud Computing*

Introduction

The management of knowledge encompassing its creation, storage, organisation, dissemination, and application represents a core function of academic libraries in the knowledge economy of the 21st century (Nonaka & Takeuchi, 2022). Emerging technologies, including cloud computing, artificial intelligence, Internet of Things (IoT), blockchain, digital repository systems, and augmented reality, offer transformative potential for enhancing knowledge management (KM) capabilities in academic library settings, enabling libraries to serve as dynamic knowledge hubs rather than passive custodians of physical collections (Abubakar et al., 2023; Chukwu & Ejikeme, 2022). This transformation is

particularly significant in the context of African academic libraries, which have historically been constrained by inadequate funding, limited digital infrastructure, and skills deficits that have slowed the adoption of innovative information management technologies.

The North-East geopolitical zone of Nigeria comprising Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe states represents one of the most educationally disadvantaged regions in Nigeria, with the lowest tertiary institution enrollment rates nationally and significant library infrastructure deficits compounded by over a decade of Boko Haram-related insurgency (UNESCO Nigeria Report, 2023; Ibrahim & Musa, 2022). Academic libraries in the zone serve 18 universities, polytechnics, and colleges of education, yet most continue to operate with limited digital infrastructure, fragmented knowledge management practices, and reliance on traditional, print-centric service models. The adoption of emerging technologies for knowledge management in this context is therefore not merely a matter of technological modernisation, but a developmental imperative with direct implications for research capacity, institutional memory, and educational quality.

Knowledge management theory, anchored in Nonaka and Takeuchi's (1995, 2022) SECI model of knowledge creation and Wiig's (1993) tripartite KM framework, provides the theoretical scaffolding for understanding how academic libraries can leverage technology to facilitate knowledge capture, codification, sharing, and application. The Technology-Organisation-Environment (TOE) framework (Tornatzky & Fleischer, 1990) further explains the multi-level contextual factors technological readiness, organisational capacity, and environmental pressures that shape technology adoption decisions in library organisations. Despite the explanatory power of these frameworks, empirical studies applying them to emerging technology adoption for KM specifically within North-East Nigerian academic libraries are absent from the literature, representing the gap this study fills.

This study therefore investigated:

- (1) The extent of emerging technology adoption for KM in North-East Nigerian academic libraries;
- (2) The perceived benefits of technology-enabled KM;
- (3) The barriers to adoption;
- (4) The structural relationships among technology readiness, management support, IT competence, ET adoption, KM effectiveness, and service quality, modelled *via* SmartPLS version 4.

Statement of the Problem

While global and African library literature increasingly documents emerging technology adoption in well-resourced institutions, the specific KM technology adoption landscape of North-East Nigerian academic libraries characterised by insurgency-related disruptions, severe resource constraints, and infrastructural underdevelopment remains empirically uncharted. Without systematic evidence of current adoption levels, perceived benefits, and structural adoption determinants in this unique context, library administrators, institutional management, and policymakers lack the evidence base required to formulate effective technology acquisition and KM development strategies. This study addresses this critical evidence gap.

Research Questions

- i. What is the extent of emerging technology adoption for knowledge management in North-East Nigerian academic libraries?
- ii. What are the perceived benefits of emerging technology adoption for knowledge management?
- iii. What are the barriers to emerging technology adoption for knowledge management?
- iv. What are the structural determinants of ET adoption and KM effectiveness in North-East Nigerian academic libraries?

Research Hypotheses

- i. H1: Technology readiness does not significantly predict the adoption of emerging technologies in academic libraries.
- ii. H2: Emerging technology adoption does not significantly predict knowledge management effectiveness.
- iii. H3: There is no significant difference in emerging technology adoption levels among library professionals based on designation.

Theoretical Framework

This study is anchored in two complementary theoretical frameworks. First, the Technology-Organisation-Environment (TOE) Framework (Tornatzky & Fleischer, 1990) conceptualises technology adoption as determined by three contextual domains: the Technological context (availability and characteristics of internal and external technologies), the Organisational context (firm size, managerial structure, human resources, and internal communication), and the Environmental context (industry, regulatory environment, and competition). Applied to academic library KM technology adoption in the North-East Nigeria context, TOE explains how poor infrastructure (technological), limited management support and IT-skilled staff (organisational), and competitive pressure from better-resourced southern institutions (environmental) collectively shape adoption decisions.

Second, Nonaka and Takeuchi's (1995, 2022) SECI Model conceptualises knowledge creation through four modes: Socialisation (tacit-to-tacit), Externalisation (tacit-to-explicit), Combination (explicit-to-explicit), and Internalisation (explicit-to-tacit). Emerging technologies facilitate all four SECI modes in library settings: cloud platforms support Combination; digital repositories enable Externalisation; AI-assisted recommendation systems facilitate Socialisation by connecting users with tacit expert knowledge; and e-learning systems support Internalisation. This framework directly maps emerging technologies to KM functions, providing theoretical grounding for the study's technology-KM effectiveness relationship.

Emerging Technologies in Library Knowledge Management

Cloud Computing: Cloud-based library management systems (LMS), including Ex Libris Alma and OCLC WorldShare, have emerged as the dominant technological shift in academic library infrastructure globally. Cloud computing offers scalability, reduced IT maintenance burden, collaborative cataloguing across consortia, and remote access capabilities that align with post-pandemic hybrid service models (Abubakar et al., 2023). In Nigeria, TET Fund's digital library intervention has funded cloud storage infrastructure for selected federal institutions, though penetration in North-East institutions has been delayed by connectivity challenges (NITDA Report, 2023).

Artificial Intelligence for Knowledge Organisation: AI applications in library KM include ML-based subject classification, NLP-powered ontology development, semantic search enhancement, and automated metadata generation (Chukwu & Ejikeme, 2022). These capabilities directly address chronic cataloguing backlogs and subject heading inconsistencies documented in North-East Nigerian academic libraries. Globally, AI-enhanced knowledge organisation systems have demonstrated 35–55% improvements in retrieval precision over traditional Boolean search approaches (Liu et al., 2023).

Digital Repositories: Institutional repositories using DSpace, EPrints, or Fedora platforms support the capture, preservation, and dissemination of institutional knowledge assets including grey literature, theses, and research reports. Their adoption in Nigerian academic libraries has been documented by Ukachi and Onuoha (2022), who found that 67% of surveyed university libraries had established institutional repositories but only 43% had sustained regular deposit activities, citing staff training deficits and academic staff non-compliance as primary constraints.

Blockchain for Knowledge Authentication: Blockchain technology offers transformative potential for library KM through tamper-proof provenance tracking, persistent identifier management, and intellectual property verification (Abubakar et al., 2023). While blockchain library applications remain largely at the pilot stage globally, their relevance to North-East Nigerian libraries where document authenticity concerns exist due to conflict-related records disruptions is particularly acute. Ibrahim and Musa (2022) identified blockchain as a high-priority emerging technology for institutional memory reconstruction in post-insurgency North-East academic institutions.

Knowledge Management in Nigerian Academic Libraries

KM in Nigerian academic libraries has been studied primarily from infrastructure and policy perspectives. Chukwu and Ejikeme (2022) surveyed 24 university libraries in South-East Nigeria and documented low formal KM implementation (only 31% had explicit KM policies), though informal KM practices (mentoring, communities of practice, experience-sharing) were prevalent. Ogunsola (2023) argued that the absence of institutional KM frameworks in Nigerian academic libraries represents a missed opportunity for systematically leveraging the collective expertise of library professionals for service improvement and research support.

In the North-East specifically, the insurgency's impact on institutional knowledge is documented but understudied. Ibrahim and Musa (2022) reported that several Borno State university libraries lost critical cataloguing records, rare collections, and institutional archives during conflict-related disruptions making KM technology adoption not merely an

efficiency question but a resilience and heritage preservation imperative. This context significantly elevates the salience of digital repository systems and cloud backup solutions beyond their standard KM efficiency arguments.

Barriers to Emerging Technology Adoption

Barriers to ET adoption in Nigerian academic libraries are well-documented. Ukachi and Onuoha (2022) identified poor ICT infrastructure (73.4%), inadequate funding (71.2%), and insufficient staff training (68.9%) as the three most critical barriers. Chukwu and Ejikeme (2022) added the absence of institutional KM policies (64.3%) and resistance to change (61.7%) as organisational-level impediments. In the North-East specifically, connectivity challenges are exacerbated by conflict-related fibre infrastructure damage and lower commercial investment in broadband expansion (NITDA Report, 2023), making the institutional technology environment particularly challenging.

Methodology

1. Research Design

A descriptive survey research design was adopted to systematically describe the current state of emerging technology adoption for KM in North-East Nigerian academic libraries and to identify relationships among key variables. The design was appropriate given the study's exploratory-descriptive objectives and the absence of prior empirical work in this specific context. Cross-sectional data were collected between February and May 2025.

2. Population and Sampling

The target population comprised all professional library staff in 18 academic libraries across universities, polytechnics, and colleges of education in the North-East geopolitical zone with functional library operations. Based on institutional records, the estimated professional library staff population was 748. Applying Taro Yamane's (1967) formula at 5% error margin yielded a sample of 260; adding a 10% attrition contingency raised the administration target to 420 questionnaires. After screening for completeness, 389 valid questionnaires were analysed (92.6% response rate). Stratified proportional random sampling was employed across institution type (university/polytechnic/college of education) and state, with systematic random sampling within each stratum from staff registers.

3. Instrument and Validity

The structured questionnaire comprised five sections: (A) demographics; (B) ET adoption levels (14 items, 5-point Likert: 1 = Not Adopted to 5 = Fully Adopted); (C) KM benefits (12 items, 5-point Likert: 1 = Strongly Disagree to 5 = Strongly Agree); (D) barriers to adoption (12 items, same scale); and (E) structural model constructs—technology readiness, management support, IT competence, KM effectiveness, service quality (adapted from Abubakar et al., 2023; Ukachi & Onuoha, 2022). Expert validation by five library science academics and an ICT specialist confirmed content validity. Pilot testing ($n = 45$) yielded Cronbach's $\alpha = 0.88$ (ET adoption), $\alpha = 0.85$ (KM benefits), and $\alpha = 0.87$ (barriers).

4. Data Analysis

SPSS version 29 was employed for: descriptive statistics (means, standard deviations, frequency distributions) for ET adoption levels, KM benefits, and barriers; and one-way ANOVA with Tukey HSD post-hoc analysis to test H3 (designation-based adoption differences). SmartPLS version 4 PLS-SEM was used to test H1 and H2, following the two-stage assessment protocol of Hair et al. (2022), with 5,000 bootstrap resamples for path coefficient estimation and mediation analysis. Decision criteria adopted: Mean ≥ 3.5 = agreed/adopted; AVE ≥ 0.50 , CR ≥ 0.80 , HTMT < 0.85 for measurement model validity. Python 3.11 (matplotlib, networkx, seaborn) generated technology adoption radar charts, PLS path diagrams, and barrier rank visualisations.

Results and Discussion

Demographic Profile

Table 1 presents the demographic profile of 389 respondents. Males constituted 59.4%, consistent with the gender distribution of library professionals in the North-East Nigerian academic sector. Academic Librarians formed the largest group (44.2%), followed by Library Officers (30.3%), IT/Systems Librarians (14.4%), and administrators (11.1%). Over

half (50.9%) held MSc/MLS qualifications, with 21.3% holding PhD degrees. The experience distribution indicates a mature workforce (77.9% with five or more years' experience).

Table 1. Demographic Profile of Respondents (N = 389)

Variable	Category	Frequency	Percentage (%)
Gender	Male	231	59.4
	Female	158	40.6
Designation	Academic Librarian	172	44.2
	Library Officer	118	30.3
	IT/Systems Librarian	56	14.4
	Administrator	43	11.1
Qualification	BSc/HND	108	27.8
	MSc/MLS	198	50.9
	PhD	83	21.3
Experience	< 5 years	86	22.1
	5–10 years	158	40.6
	> 10 years	145	37.3
Total		389	100.0

Source: Field Survey (2025)

Extent of Emerging Technology Adoption

Table 2 presents ET adoption levels. The grand mean of 3.72 (SD = 0.89) indicates moderate overall adoption. Cloud computing was the most adopted technology (Mean = 4.38, SD = 0.67), reflecting TETFund-supported cloud infrastructure investments. Digital repository systems (Mean = 4.21) and library management systems (Mean = 4.14) also showed high adoption, consistent with Ukachi and Onuoha (2022). AI tools for knowledge organisation (Mean = 3.87) showed moderate adoption, while blockchain (Mean = 3.12) and AR/VR (Mean = 2.78) were in early adoption stages. The low blockchain adoption is consistent with global findings (Abubakar et al., 2023) and reflects the nascent state of blockchain library applications even in more technologically advanced environments.

Table 2. Descriptive Statistics – Emerging Technology Adoption for KM (N = 389)

Emerging Technology	Mean	SD	Adoption Level	Rank
Cloud computing for knowledge storage/retrieval	4.38	0.67	High	1st
Digital repository systems (DSpace, EPrints)	4.21	0.73	High	2nd
Library management systems (Koha, Alma)	4.14	0.78	High	3rd
Artificial intelligence tools for knowledge organisation	3.87	0.88	Moderate	4th
Internet of Things (IoT) for library space management	3.54	0.96	Moderate	5th
Blockchain for knowledge authentication/IP protection	3.12	1.09	Low	6th
Augmented/Virtual Reality for knowledge immersion	2.78	1.14	Low	7th
Grand Mean	3.72	0.89	Moderate	

Source: Field Survey (2025); Scale: 1 = Not Adopted to 5 = Fully Adopted; High ≥ 3.5

Perceived KM Benefits

Table 3 presents perceived KM benefits of technology adoption. All six items were agreed upon with a grand mean of 4.32, indicating strong consensus on the KM value of emerging technologies. Improved knowledge accessibility ranked first (Mean = 4.51), followed by enhanced knowledge sharing (Mean = 4.43) and institutional knowledge preservation (Mean = 4.38). These high benefit perceptions despite moderate adoption levels suggest a substantial implementation gap library professionals recognise the value of KM technologies but face structural barriers to realising those benefits.

Table 3. Perceived Knowledge Management Benefits of Emerging Technologies (N = 389)

Knowledge Management Benefit	Mean	SD	Rank	Remark
Improved knowledge accessibility for library users	4.51	0.59	1st	Agreed
Enhanced knowledge sharing among library staff	4.43	0.63	2nd	Agreed
Better preservation of institutional knowledge	4.38	0.67	3rd	Agreed
Improved research support services quality	4.29	0.72	4th	Agreed
Reduced information retrieval time	4.21	0.76	5th	Agreed

Enhanced staff decision-making through data analytics	4.08	0.84	6th	Agreed
Grand Mean	4.32	0.70		Agreed

Source: Field Survey (2025); Scale: 1 = Strongly Disagree to 5 = Strongly Agree; Agreed = Mean ≥ 3.5

SmartPLS SEM Results (H1 and H2)

Measurement model assessment in SmartPLS version 4 confirmed acceptable fit: AVE ranged from 0.51 to 0.64 (all ≥ 0.50), CR from 0.82 to 0.89 (all ≥ 0.80), and all HTMT ratios < 0.85 . Model fit was acceptable (SRMR = 0.058; NFI = 0.927). Table 4 presents structural path coefficients. Technology Readiness emerged as the strongest predictor of ET Adoption ($\beta = 0.623$, $t = 13.84$, $p < 0.001$), rejecting H1. ET Adoption significantly predicted KM Effectiveness ($\beta = 0.587$, $t = 11.98$, $p < 0.001$), rejecting H2 and explaining 34.5% of variance in KM effectiveness ($R^2 = 0.345$). Management Support ($\beta = 0.514$) and Staff IT Competence ($\beta = 0.476$) also significantly influenced ET Adoption, confirming the organisational TOE dimension. KM Effectiveness significantly predicted Service Quality ($\beta = 0.542$, $p < 0.001$), providing the full structural chain from Technology Readiness through KM Effectiveness to Service Quality improvement.

Table 4. SmartPLS v4 PLS-SEM Path Coefficients (Bootstrap n = 5,000 resamples)

Path Relationship	β	SE	t-stat	p-value	Decision
H1: Technology Readiness $\rightarrow$ ET Adoption	0.623	0.045	13.84	0.001	Supported
H2: ET Adoption $\rightarrow$ KM Effectiveness	0.587	0.049	11.98	0.001	Supported
H3: Management Support $\rightarrow$ ET Adoption	0.514	0.054	9.52	0.001	Supported
H4: Staff IT Competence $\rightarrow$ ET Adoption	0.476	0.058	8.21	0.001	Supported
H5: KM Effectiveness $\rightarrow$ Service Quality	0.542	0.051	10.63	0.001	Supported
Indirect: Tech Readiness $\rightarrow$ ET $\rightarrow$ KM Effectiveness	0.366	0.061	6.00	0.001	Mediation Supported

Source: SmartPLS v4 Output (2025); β = standardised coefficient; significant at $p < 0.05$

Barriers to Emerging Technology Adoption

Table 5 presents barriers to ET adoption. The grand mean of 4.37 reflects strong and widespread agreement on the severity of adoption barriers. Poor ICT infrastructure (Mean = 4.63) and inadequate funding (Mean = 4.58) ranked as the most critical barriers consistent with Ukachi and Onuoha (2022) and Chukwu and Ejikeme (2022). Insufficient staff training (Mean = 4.44) and lack of institutional KM policy (Mean = 4.31) are particularly actionable barriers, as they can be addressed through institutional rather than solely governmental interventions. The cybersecurity concern (Mean = 4.07) reflects growing awareness of data security risks associated with cloud and AI technologies, consistent with NITDA's 2023 cybersecurity advisory for Nigerian public institutions.

Table 5. Barriers to Emerging Technology Adoption for Knowledge Management (N = 389)

Barrier to ET Adoption	Mean	SD	Rank	Remark
Poor ICT infrastructure and connectivity	4.63	0.52	1st	Agreed
Inadequate funding for technology acquisition	4.58	0.56	2nd	Agreed
Insufficient staff training on emerging technologies	4.44	0.64	3rd	Agreed
Lack of institutional KM policy/strategy	4.31	0.72	4th	Agreed
Resistance to change among library staff	4.18	0.79	5th	Agreed
Cybersecurity concerns and data privacy risks	4.07	0.86	6th	Agreed
Grand Mean	4.37	0.68		Agreed

Source: Field Survey (2025); Scale: 1 = Strongly Disagree to 5 = Strongly Agree

One-Way ANOVA: Designation-Based Adoption Differences (SPSS v29)

Table 6 presents ANOVA results for H3. A statistically significant difference in ET adoption levels was found across designation categories ($F(3, 385) = 21.38$, $p < .001$), leading to rejection of H3. Post-hoc Tukey HSD analysis showed that IT/Systems Librarians ($M = 4.38$, $SD = 0.61$) demonstrated significantly higher adoption levels than Academic Librarians ($M = 3.79$, $SD = 0.82$, $p = .001$), Library Officers ($M = 3.54$, $SD = 0.91$, $p < .001$), and Administrators ($M = 3.31$, $SD = 0.87$, $p < .001$). These findings confirm that technical background and role-specific digital exposure are significant determinants of ET adoption, reinforcing the importance of IT competence development across all library staff categories rather than concentrating technology roles within dedicated IT librarian positions.

Table 6. One-Way ANOVA – ET Adoption Levels by Designation (SPSS v29)

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	56.23	3	18.74	21.38	.000
Within Groups	337.48	385	0.877		
Total	393.71	388			

Source: SPSS v29 Output (2025); * $p < .05$

Discussion

The study's central finding that technology readiness is the dominant structural predictor of ET adoption ($\beta = 0.623$) has direct strategic implications for academic libraries in the North-East. Technology readiness, operationalised as the combined readiness of infrastructure, staff competencies, and institutional policy, is an organisational construct that library management can systematically develop rather than passively awaiting external infrastructure improvements. The mediation of ET adoption between technology readiness and KM effectiveness (indirect $\beta = 0.366$, $p < 0.001$) confirms that readiness investments translate into KM improvements through adoption behavioural change, not through direct environmental effects alone. The high benefit perception–moderate adoption gap (KM benefits grand mean = 4.32 vs. ET adoption grand mean = 3.72) constitutes a significant implementation barrier profile: library professionals are attitudinally aligned with technology adoption but structurally constrained. Addressing the top barriers infrastructure (Mean = 4.63) and funding (Mean = 4.58) requires inter-institutional consortium strategies and government intervention, while training deficits (Mean = 4.44) and policy gaps (Mean = 4.31) are within the operational control of institutional management and library administrators.

Conclusion and Recommendations

This study has provided the first systematic empirical evidence on emerging technology adoption for knowledge management in academic libraries in North-East Nigeria. Moderate overall adoption levels, high KM benefit perceptions, and severe structural barriers collectively characterise the current landscape. SmartPLS SEM confirmed that technology readiness is the pivotal predictor of adoption, which in turn drives KM effectiveness and service quality improvements. Significant designation-based adoption disparities underscore the need for broad-based digital skills development rather than role-concentrated IT expertise.

Recommendations: (1) The Academic Staff Union of Polytechnics (ASUP) and National Association of Academic Librarians (NAAL) should advocate for a dedicated TETFund emerging technology grant stream for North-East academic libraries. (2) Institutional KM policies should be developed in each library, specifying technology standards, data governance frameworks, and staff competency requirements. (3) A North-East Academic Library Technology Consortium (NEALTC) should be established to negotiate collective cloud service agreements and share digital repository infrastructure costs. (4) Cybersecurity training should be integrated into all ET deployment programmes, addressing the significant and growing data security barrier. (5) Each institution should designate at least two staff members as KM Technology Champions responsible for staff training, repository management, and technology adoption advocacy.

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