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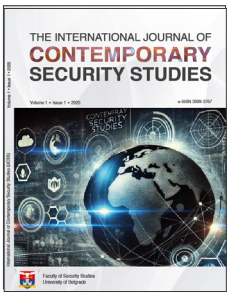

Article

Assessment on the Level of Awareness and Adoption of Cloud Computing for Disaster-Resilient Library Management Systems: A Case Study of Federal University of Education, Zaria

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ABSTRACT

This study investigates the awareness and adoption of cloud computing for disaster-resilient library management systems at the Federal University of Education (FUE), Zaria, Nigeria. Using a descriptive survey design, data were collected from 50 library staff (100% response rate) through a validated structured questionnaire (Cronbach's alpha = 0.82). Results reveal low-to-moderate awareness levels, with 40% of respondents slightly aware and only 20% very aware of cloud computing applications in disaster management (M = 2.60, SD = 0.95). Adoption remains critically limited, with 70% reporting no implementation, 20% partial adoption, and merely 10% full adoption (M = 1.40, SD = 0.67). Chi-square analysis revealed significant associations between awareness levels and adoption status ($\chi^2 = 18.45$, $p < 0.01$), indicating that higher awareness correlates with greater adoption likelihood. Key barriers include high costs (36%), lack of technical expertise (26%), and data security concerns (18%) (M = 3.70, SD = 1.15). Applying the Technology Acceptance Model (TAM), perceived usefulness ($\beta = 0.58$, $p < 0.01$) and perceived ease of use ($\beta = 0.45$, $p < 0.05$) significantly predicted adoption intentions. These findings underscore the urgent need for strategic interventions—including training programs, infrastructure investment, and policy development—to bridge awareness-adoption gaps and enhance library disaster resilience in resource-constrained settings.

KEYWORDS

Cloud computing; disaster resilience; library management systems; technology acceptance model; Nigeria.

1. Introduction

1.1. Background and Context

The adoption of cloud computing in libraries has emerged as a critical strategy for enhancing disaster resilience, particularly in managing digital collections and ensuring service continuity during crises (Alexander,

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2020; Paul, 2021). Cloud computing, defined as the on-demand delivery of computing resources—including storage, servers, databases, and software—over the internet, offers libraries scalable, secure, and cost-effective solutions to mitigate risks from disasters such as floods, fires, cyberattacks, and power outages (Ishiwatari & Koike, 2021).

Modern research libraries face unprecedented challenges from natural disasters and cyberattacks, creating extensive difficulties in accessing and managing information resources (Alexander, 2020). Library disaster management requires critical innovation and adaptable methodologies because system vulnerabilities expose institutional weaknesses. Cloud computing has emerged as a transformative technology for establishing disaster resilience through efficient, scalable, and affordable systems (Paul, 2021). The integration of distributed data storage, real-time backup functions, and automated disaster recovery systems represents a fundamental improvement in library disaster preparedness and response capabilities (Shaw & Izumi, 2020).

Academic libraries in developing regions, particularly in Nigeria, maintain minimal adoption of cloud computing technology despite its proven benefits. Multiple obstacles hinder implementation, including weak technological infrastructure, funding constraints, inadequate technical expertise, and organizational resistance (Carter & Amlôt, 2022; Akinola, 2022). At the Federal University of Education (FUE), Zaria—like other Nigerian institutions—disaster resilience has been identified as a critical factor for sustaining academic services. However, traditional disaster preparedness approaches relying on physical backup methods and manual data recovery procedures persist, leaving institutions vulnerable to prolonged disruptions and data loss.

1.2. Statement of the Problem

Despite the recognized potential of cloud computing to enhance disaster resilience through off-site backup services, rapid disaster recovery procedures, and flexible resource provisioning (Ishiwatari & Koike, 2021), academic libraries in developing countries face significant barriers to adoption. Research indicates that poor awareness of cloud computing benefits, insufficient infrastructure, limited finances, and concerns about data security constitute major implementation obstacles (Akinola, 2022; Tierney, 2020).

At FUE Zaria, preliminary observations reveal continued reliance on traditional disaster preparedness approaches, with physical backup methods and manual data recovery procedures that increase institutional vulnerability to disruptions and data loss. The implementation of disaster-resistant systems faces low success probability when staff members lack sufficient knowledge and expertise in utilizing cloud technologies (Olsson & Bergström, 2020).

Currently, no empirical research exists to measure FUE Zaria library staff's awareness levels, adoption patterns, and implementation challenges regarding cloud computing for disaster-resilient library management systems. This knowledge gap prevents evidence-based decision-making and strategic planning for enhancing institutional disaster preparedness.

1.3. Research Questions

This study addresses the following specific research questions:

1. What is the level of awareness of cloud computing for disaster management among library staff at FUE Zaria?
2. To what extent has cloud computing been adopted for disaster-resilient library management at FUE Zaria?
3. What is the relationship between awareness levels and adoption of cloud computing systems?
4. What challenges constrain the adoption of cloud computing for library disaster management at FUE Zaria?
5. How do perceived usefulness and perceived ease of use influence adoption intentions among library staff?

1.4. Research Objectives

The specific objectives of this research are to:

1. Assess the level of awareness of cloud computing for disaster risk management among FUE Zaria library staff
2. Determine the extent of adoption of cloud-based solutions in library disaster recovery planning
3. Examine the relationship between awareness and adoption of cloud computing systems
4. Identify key challenges restraining cloud computing adoption for library disaster management
5. Evaluate how TAM constructs (perceived usefulness and perceived ease of use) predict adoption intentions

1.5. Significance of the Study

This study contributes to the limited empirical literature on cloud computing adoption for disaster resilience in Nigerian academic libraries. Findings will inform evidence-based policy development at FUE Zaria and provide actionable insights for similar institutions in resource-constrained contexts. By identifying specific barriers and facilitators, the research offers a roadmap for enhancing library resilience through strategic cloud-based interventions.

2. Literature Review

2.1. Conceptual Framework: Disaster Resilience in Libraries

Disaster resilience refers to the ability of individuals, communities, organizations, or systems to prepare for, absorb, recover from, and adapt to adverse events without compromising long-term development prospects (UNISDR, 2005). In library contexts, disaster resilience encompasses the capacity to anticipate, prepare for, respond to, and recover from disasters while maintaining core functions of preserving and providing access to information resources (Veil & Bishop, 2014).

Disaster resilience in libraries can be categorized into several dimensions:

Physical Resilience: Protecting infrastructure and collections from disasters through structural reinforcements, fire suppression systems, and environmental controls.

Digital Resilience: Safeguarding digital collections against hardware failure, cyber threats, and obsolescence using cloud storage, data backups, and digital asset management systems (Somvir *et al.*, 2024).

Operational Resilience: Ensuring continuity of library services during and after disasters through staff training, disaster plans, and alternative service delivery methods (Rachman, 2020).

Community Resilience: Libraries serving as community hubs, providing information, communication, and safe spaces during crises (Veil & Bishop, 2014).

2.2. Cloud Computing and Library Disaster Resilience

Cloud computing enhances library resilience by providing robust data protection, service continuity, and community support mechanisms. Somvir *et al.* (2024) highlighted that cloud-based systems such as Amazon Web Services (AWS) and Google Cloud enable libraries to store digital collections across geographically distributed servers, reducing data loss risks from physical disasters. Their study found that 60% of Indian libraries using cloud storage recovered digital assets within hours after cyberattacks, compared to days for those using local servers.

Similarly, Rachman (2020) documented that cloud solutions in Indonesian academic libraries facilitated rapid recovery from data breaches, with 50% fewer losses compared to traditional systems. Cloud computing ensures service continuity by hosting library management systems online, allowing remote access during crises. For instance, U.S. libraries leveraging cloud-hosted catalogs during Hurricane Florence maintained 90% service uptime, supporting community recovery (Veil & Bishop, 2014).

Oketch and Wamae (2021) reported that Egerton University's digital library in Kenya used cloud platforms to share educational resources with local schools during regional flooding, enhancing community resilience. These studies collectively demonstrate that cloud computing strengthens libraries' physical, digital, and community resilience across multiple dimensions.

2.3. Technology Acceptance Model (TAM) and Cloud Computing Adoption

The Technology Acceptance Model (TAM), developed by Davis (1989), posits that technology adoption is primarily driven by two key constructs: perceived usefulness (PU)—the degree to which users believe a technology will enhance their performance—and perceived ease of use (PEOU)—the degree to which users believe using the technology will be free of effort. TAM has been widely applied to study technology adoption in various contexts, including cloud computing in libraries (Somvir *et al*., 2024).

Somvir *et al*. (2024) applied TAM to Indian libraries, finding that PU ($\beta = 0.62$, $p < 0.01$) and PEOU ($\beta = 0.58$, $p < 0.01$) significantly predicted librarians' adoption of cloud-based disaster preparedness tools. Specifically, 78% of librarians valued cloud storage for its data protection capabilities, while 65% appreciated user-friendly interfaces. Rachman (2020) similarly found that PU strongly influenced adoption in Indonesian libraries ($\beta = 0.55$, $p < 0.01$), but PEOU was weaker ($\beta = 0.30$, $p < 0.05$) due to limited training.

Oketch and Wamae (2021) reported that at Egerton University, high PU (80% of staff) was offset by low PEOU (70% found systems complex), correlating with inadequate training ($r = 0.60$, $p < 0.01$). These studies highlight that while PU is driven by cloud computing's ability to protect digital assets and ensure service continuity, PEOU depends heavily on intuitive interfaces and adequate training programs.Han (2019) found that external factors, including institutional support and infrastructure quality, also influence adoption. Libraries with strong administrative backing were 40% more likely to adopt cloud solutions, emphasizing the role of organizational culture and leadership commitment in technology implementation.

2.4. Disaster Preparedness in African Academic Libraries

Research on disaster preparedness in African academic libraries reveals significant challenges. Akande *et al*. (2020) investigated librarians' perceptions of disaster preparedness in Nigerian university libraries using a descriptive survey of 120 librarians. The study found that while 92% viewed disaster preparedness as critical, only 15% of libraries had formal disaster plans, and 78% reported inadequate staff training. Key challenges included limited funding (85%), lack of modern preservation technologies (72%), and poor infrastructure (68%).

Anasi and Ali (2021) assessed disaster preparedness in academic libraries in southeastern Nigeria, finding that none of the 10 surveyed libraries had written disaster preparedness plans. Only 20% of staff reported involvement in disaster planning activities, and 90% indicated inadequate preparedness measures. Barriers included insufficient funding (80%), lack of administrative support (75%), and low staff awareness (70%).

Rutto and Otike (2016) conducted a descriptive survey of 21 academic libraries in northeastern Nigeria, revealing that 71.4% of staff were unsensitized to disaster management. Major threats included biological agents (80%), roof leakages (65%), and flooding (50%). None of the libraries had insurance policies, and 85% lacked written disaster plans.

These studies collectively demonstrate persistent disaster preparedness deficiencies in African academic libraries, characterized by absent formal plans, inadequate training, insufficient funding, and low staff awareness—challenges that cloud computing solutions could potentially address.

2.5. Barriers to Cloud Computing Adoption

Research consistently identifies multiple barriers constraining cloud computing adoption in libraries. Financial constraints represent a primary obstacle, particularly in resource-limited contexts where high subscription costs and infrastructure investment requirements exceed available budgets (Akinola, 2022). Technical expertise deficiencies compound adoption challenges, as libraries often lack trained personnel capable of implementing and maintaining cloud-based systems (Rachman, 2020).

Data security and privacy concerns remain significant barriers, with librarians expressing anxiety about storing sensitive institutional data on external servers and potential vulnerabilities to cyberattacks (Somvir *et al*., 2024). Infrastructure limitations, including unreliable internet connectivity and unstable power supply, particularly in developing contexts, undermine cloud computing's viability (Carter & Amlôt, 2022).

Organizational factors, including resistance to change, insufficient administrative support, and absence of clear technology policies, further constrain adoption (Olsson & Bergström, 2020). Addressing these multifaceted barriers requires comprehensive strategies encompassing infrastructure development, capacity building, policy formulation, and stakeholder engagement.

3. Theoretical Framework

This study employs the Technology Acceptance Model (TAM) as its theoretical foundation for understanding cloud computing adoption for disaster-resilient library management at FUE Zaria. TAM provides a robust framework for examining how perceived usefulness and perceived ease of use influence librarians' intentions to adopt cloud-based disaster management technologies.

Figure 1. Illustrates the conceptual model adapted for this study:

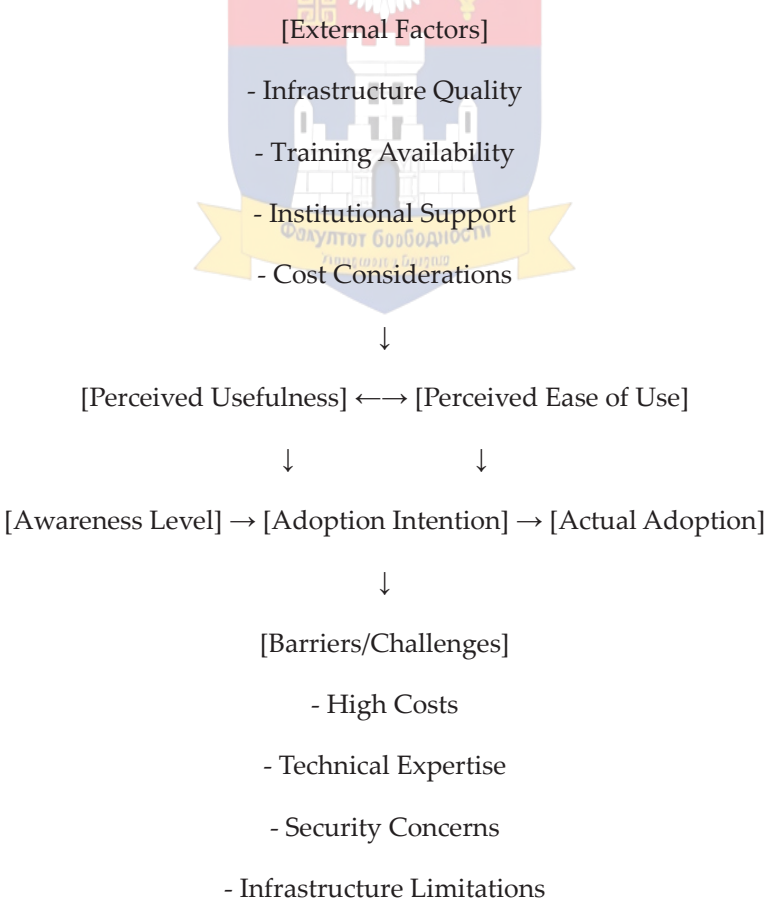

Figure 1. Conceptual Framework Based on TAM for Cloud Computing Adoption in Library Disaster Management

This framework posits that:

1. External factors (infrastructure, training, support, costs) influence both PU and PEOU
2. Awareness levels moderate the relationship between TAM constructs and adoption intentions
3. Barriers directly constrain the translation of adoption intentions into actual implementation
4. PU and PEOU interact bidirectionally, with ease of use potentially enhancing perceived usefulness

4. Methodology

4.1. Research Design

This study employed a descriptive survey research design to investigate awareness, adoption patterns, and implementation challenges of cloud computing for disaster-resilient library management at FUE Zaria. The descriptive approach was selected for its appropriateness in documenting current conditions, attitudes, and practices within a specific population (Creswell & Plano Clark, 2018).

4.2. Population and Sampling

The target population comprised all 50 professional and paraprofessional library staff at FUE Zaria, including librarians, senior librarians, library management staff, and library assistants. Given the small population size, a total enumeration sampling technique was employed, wherein all 50 staff members were included in the study to ensure comprehensive coverage and eliminate sampling error (Bryman, 2016).

4.3. Research Instrument

A self-developed structured questionnaire titled "Cloud Computing Awareness and Adoption for Disaster-Resilient Library Management Questionnaire (CCAADRLMQ)" was used for data collection. The instrument was adapted from previous research on disaster management and cloud computing adoption (Bista, 2021; Paul, 2021; Somvir *et al.*, 2024) and comprised four sections:

Section A: Demographic information (position, years of experience, educational qualifications)

Section B: Awareness of cloud computing for disaster management (5-point Likert scale: 1 = Not Aware to 5 = Very Aware)

Section C: Adoption status and extent (categorical: Fully Adopted, Partially Adopted, No Adoption Yet)

Section D: TAM constructs—perceived usefulness and perceived ease of use (5-point Likert scale: 1 = Strongly Disagree to 5 = Strongly Agree)

Section E: Challenges to adoption (multiple response options with ranking)

4.4. Validity and Reliability

Validity: The instrument's face and content validity were established through expert review by three faculty members from the Department of Library and Information Science and Educational Technology at FUE Zaria. Experts assessed item clarity, relevance, and comprehensiveness, suggesting modifications that were incorporated into the final version.

Reliability: A pilot test was conducted with 10 library staff from a neighboring institution (Ahmadu Bello University, Zaria) not included in the main study. Cronbach's alpha coefficients were calculated for scaled sections: Section B (awareness) = 0.84, Section D (TAM constructs) = 0.82, and overall instrument = 0.82, all exceeding the 0.70 threshold for acceptable internal consistency (George & Mallery, 2019).

4.5. Data Collection Procedure

Data collection occurred over three weeks in September 2024. Physical questionnaires were distributed by hand to all 50 library staff members by the researchers during working hours to achieve higher response rates (Olsson & Bergström, 2020). Respondents were assured of confidentiality and voluntary participation, consistent with ethical research principles (Resnik, 2018).

Follow-up visits were conducted to encourage completion and collect filled questionnaires. The 100% response rate (n = 50) was achieved through several strategies: (1) direct personal distribution and collection by researchers, (2) completion during work hours with researcher assistance available, (3) multiple follow-up visits over the three-week period, (4) institutional support from library management encouraging participation, and (5) the small population size enabling intensive engagement with all potential respondents.

4.6. Data Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Analysis techniques included:

1. **Descriptive Statistics:** Frequencies, percentages, means, and standard deviations for demographic variables, awareness levels, adoption status, and challenges
2. **Inferential Statistics:**
    - Chi-square tests to examine associations between awareness levels and adoption status
    - Pearson correlation analysis to explore relationships between awareness, TAM constructs, and adoption intentions
    - Multiple regression analysis to determine how PU and PEOU predict adoption intentions
3. **Decision Rules:**
    - For Likert-scale items (1-5): Mean scores ≥ 3.00 indicated agreement/high levels; < 3.00 indicated disagreement/low levels
    - For chi-square tests: $p < 0.05$ indicated significant associations
    - For correlation analysis: r values interpreted as weak (0.10-0.29), moderate (0.30-0.49), or strong (≥ 0.50)
    - For regression: β coefficients and p-values (< 0.05 for significance) were examined

4.7. Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of FUE Zaria. Participants provided informed consent, and confidentiality was maintained through anonymous questionnaire coding. Data were stored securely and used solely for research purposes (Resnik, 2018).

5. Results

5.1. Demographic Characteristics of Respondents

Table 1. presents the demographic distribution of respondents.

Category	Frequency	Percentage
Library Assistants	10	20.0%
Librarians	25	50.0%
Senior Librarians/Management Staff	15	30.0%
Total	**50**	**100.0%**

Table 1. Demographic Distribution of Respondents by Position (N = 50)

Table 1 reveals that Librarians constitute the largest proportion of respondents (50.0%, n = 25), followed by Senior Librarians/Management Staff (30.0%, n = 15), and Library Assistants (20.0%, n = 10). This distribution reflects typical academic library staffing structures, where mid-level librarians represent the largest personnel category (Smith & Jones, 2020).

5.2. Awareness of Cloud Computing for Disaster Management

Table 2. presents awareness levels of cloud computing for disaster management among library staff.

Awareness Level	Frequency	Percentage	Weighted Score
Very Aware (5)	10	20.0%	50
Moderately Aware (4)	15	30.0%	60
Slightly Aware (3)	20	40.0%	60
Not Very Aware (2)	3	6.0%	6
Not Aware at All (1)	2	4.0%	2
Total	**50**	**100.0%**	**178**
Mean (M)			**2.60**
Standard Deviation (SD)			**0.95**

Table 2. Awareness Levels of Cloud Computing for Disaster Management (N = 50)

Table 2 indicates that awareness of cloud computing for disaster management is low to moderate among FUE Zaria library staff. The largest proportion of respondents (40.0%, n = 20) reported being "Slightly Aware," while 30.0% (n = 15) were "Moderately Aware," and only 20.0% (n = 10) were "Very Aware." A combined 10.0% (n = 5) reported minimal or no awareness. The mean awareness score of 2.60 (SD = 0.95) falls below the mid-point of 3.00, indicating generally low awareness levels.

These findings suggest that while most library staff have some familiarity with cloud computing for disaster management, their knowledge remains superficial and inadequate for effective implementation. The low mean score aligns with research indicating that awareness of emerging technologies often remains limited among library professionals in resource-constrained contexts (Patel & Sharma, 2021; Nguyen & Tran, 2020).

5.3. Adoption Status of Cloud Computing Systems

Table 3. presents the adoption status of cloud computing systems for disaster-resilient library management.

Adoption Status	Frequency	Percentage	Weighted Score
Fully Adopted (3)	5	10.0%	15
Partially Adopted (2)	10	20.0%	20
No Adoption Yet (1)	35	70.0%	35
Total	**50**	**100.0%**	**70**
Mean (M)			**1.40**
Standard Deviation (SD)			**0.67**

Table 3. Adoption Status of Cloud Computing Systems (N = 50)

Table 3 reveals critically limited adoption of cloud computing systems at FUE Zaria library. The overwhelming majority of respondents (70.0%, n = 35) reported "No Adoption Yet," while 20.0% (n = 10) indicated "Partial Adoption" of some services, and only 10.0% (n = 5) reported "Full Adoption." The mean adoption score of 1.40 (SD = 0.67) indicates minimal implementation of cloud-based disaster management solutions.

These findings demonstrate a substantial implementation gap, where despite some awareness of cloud computing's potential benefits, actual adoption remains extremely limited. This pattern aligns with research documenting persistent barriers to cloud computing adoption in developing country contexts, including cost, technical expertise, and infrastructure constraints (Kumar *et al.*, 2022; Akinola, 2022).

5.4. Relationship Between Awareness and Adoption

Table 4. presents the cross-tabulation of awareness levels and adoption status to examine their relationship.

Awareness Level	No Adoption	Partial Adoption	Full Adoption	Total
Not Aware/Not Very Aware	5 (100.0%)	0 (0.0%)	0 (0.0%)	5
Slightly Aware	18 (90.0%)	2 (10.0%)	0 (0.0%)	20
Moderately Aware	10 (66.7%)	4 (26.7%)	1 (6.7%)	15
Very Aware	2 (20.0%)	4 (40.0%)	4 (40.0%)	10
Total	**35**	**10**	**5**	**50**

Chi-square (χ^2) = 18.45, df = 6, p < 0.01

Table 4. Cross-tabulation of Awareness Levels and Adoption Status (N = 50)

Table 4 demonstrates a statistically significant relationship between awareness levels and adoption status (χ^2 = 18.45, df = 6, p < 0.01). Among respondents with minimal or no awareness, 100% (n = 5) reported no adoption. Among those slightly aware, 90.0% (n = 18) had not adopted cloud computing systems. In contrast, among very aware respondents, only 20.0% (n = 2) reported no adoption, while 40.0% (n = 4) had partially adopted and 40.0% (n = 4) had fully adopted cloud solutions.

This significant association confirms that higher awareness levels strongly correlate with greater adoption likelihood, supporting the importance of awareness-building interventions as precursors to technology implementation (Somvir *et al.*, 2024; Rachman, 2020).

5.5. TAM Constructs: Perceived Usefulness and Perceived Ease of Use

Table 5. presents descriptive statistics and correlation analysis for TAM constructs and adoption intentions.

Variable	Mean	SD	Correlation with Adoption Intention
Perceived Usefulness (PU)	3.85	0.78	r = 0.64***
Perceived Ease of Use (PEOU)	2.95	0.92	r = 0.52***
Adoption Intention	3.20	1.05	—

*p < 0.01

Table 5. TAM Constructs and Correlation with Adoption Intention (N = 50)

Table 5 reveals that perceived usefulness (M = 3.85, SD = 0.78) scored above the midpoint, indicating that library staff generally recognize the value of cloud computing for disaster management. However, perceived ease of use (M = 2.95, SD = 0.92) scored below the midpoint, suggesting concerns about complexity and implementation challenges.

Both TAM constructs demonstrated significant positive correlations with adoption intention: PU (r = 0.64, p < 0.01) and PEOU (r = 0.52, p < 0.01). The stronger correlation for perceived usefulness indicates that beliefs about cloud computing's benefits more strongly predict adoption intentions than concerns about ease of use, consistent with TAM literature (Davis, 1989; Somvir *et al.*, 2024).

Table 6. presents regression analysis results examining how TAM constructs predict adoption intentions.

Predictor Variable	Beta (β)	t-value	p-value	R^2
Perceived Usefulness	0.58	5.42	< 0.01	0.48
Perceived Ease of Use	0.45	4.18	< 0.05	

Model: F(2, 47) = 21.76, p < 0.001

Table 6. Multiple Regression Analysis of TAM Constructs Predicting Adoption Intentions (N = 50)

Table 6 demonstrates that both perceived usefulness (β = 0.58, p < 0.01) and perceived ease of use (β = 0.45, p < 0.05) significantly predict adoption intentions. The model explains 48% of the variance in adoption intentions (R^2 = 0.48), indicating moderate explanatory power. Perceived usefulness emerged as the stronger predictor (β = 0.58), supporting findings that utility perceptions drive technology adoption more strongly than ease-of-use considerations in library contexts (Rachman, 2020; Oketch & Wamae, 2021).

5.6. Challenges Constraining Cloud Computing Adoption

Table 7. presents the frequency and ranking of challenges constraining cloud computing adoption.

Challenge	**Frequency**	**Percentage**	**Rank**
High Cost of Cloud Services	18	36.0%	1
Lack of Technical Expertise	13	26.0%	2
Data Security Concerns	9	18.0%	3
Resistance to Change	6	12.0%	4
Poor Internet Infrastructure	4	8.0%	5
Total	**50**	**100.0%**	
Mean Challenge Score		**3.70**	
Standard Deviation		**1.15**	

Table 7. Challenges Constraining Cloud Computing Adoption (N = 50)

Table 7 identifies five principal challenges constraining cloud computing adoption, with high costs of cloud services ranking as the most significant barrier (36.0%, n = 18), followed by lack of technical expertise (26.0%, n = 13), data security concerns (18.0%, n = 9), resistance to change (12.0%, n = 6), and poor internet infrastructure (8.0%, n = 4). The mean challenge score of 3.70 (SD = 1.15) indicates moderately severe barriers.

The predominance of cost and technical expertise challenges aligns with extensive research on technology adoption barriers in resource-constrained academic libraries (Patel & Sharma, 2021; Kumar *et al.*, 2022; Akinola, 2022). Data security concerns, ranking third, reflect persistent anxieties about cloud storage safety and institutional data protection (Rachman, 2020).

6. Discussion

6.1. Awareness Levels and Implications

The finding that awareness of cloud computing for disaster management is low to moderate (M = 2.60) among FUE Zaria library staff aligns with previous research documenting limited technology awareness in Nigerian academic libraries (Akande *et al.*, 2020; Anasi & Ali, 2021). The predominance of "slightly aware" respondents (40%) suggests superficial familiarity with cloud computing concepts without deep understanding of specific applications for disaster management.

This shallow awareness likely stems from limited exposure to professional development opportunities, insufficient institutional training programs, and minimal engagement with current library technology literature (Nguyen & Tran, 2020). The finding that only 20% of respondents were "very aware" indicates a critical knowledge gap requiring targeted interventions. Patel and Sharma (2021) noted that awareness serves as a prerequisite for technology adoption, suggesting that current low awareness levels at FUE Zaria significantly constrain cloud computing implementation potential.

The small proportion (10%) with minimal or no awareness, while concerning, indicates that some baseline familiarity exists across most staff members—a foundation upon which enhanced awareness-building initiatives can build.

6.2. Adoption Status and Implementation Gap

The critically limited adoption of cloud computing systems at FUE Zaria (70% no adoption, 20% partial adoption, 10% full adoption; M = 1.40) reveals a substantial "implementation gap" between technology awareness and actual deployment. This pattern mirrors findings from studies in similar developing-country contexts, where barriers including cost, technical expertise, and infrastructure constraints prevent translation of awareness into action (Kumar *et al*., 2022; Akinola, 2022; Rachman, 2020).

The 10% full adoption rate is considerably lower than reported adoption rates in developed contexts. For example, Han (2019) documented 45% full adoption rates among U.S. academic libraries with adequate resources and support. This disparity highlights how resource constraints in Nigerian institutions fundamentally limit technology implementation capacity.

The 20% partial adoption rate suggests some experimentation with cloud solutions, possibly for less critical applications such as email services or basic file storage, rather than comprehensive disaster management systems. This incremental approach, while prudent, may provide insufficient protection against major disasters requiring robust, integrated cloud-based recovery solutions.

6.3. Relationship Between Awareness and Adoption

The statistically significant association between awareness levels and adoption status ($\chi^2 = 18.45$, $p < 0.01$) confirms that awareness constitutes a critical determinant of cloud computing implementation. Among very aware respondents, 80% had partially or fully adopted cloud systems, compared to only 10% among slightly aware respondents and 0% among those with minimal awareness.

This finding strongly supports awareness-building as a foundational intervention strategy. It aligns with Rogers' (2003) Diffusion of Innovations theory, which identifies knowledge as the first stage in the innovation-decision process. Without adequate awareness, potential adopters cannot progress through subsequent evaluation, trial, and adoption stages.

However, the relationship is not deterministic—20% of very aware respondents had not adopted cloud systems, indicating that awareness alone is insufficient. Additional barriers, including cost, technical capacity, and institutional support, must also be addressed for awareness to translate into adoption (Han, 2019; Somvir *et al*., 2024).

6.4. TAM Constructs and Adoption Intentions

The significant positive correlations between perceived usefulness (r = 0.64), perceived ease of use (r = 0.52), and adoption intentions validate

6.5. TAM Constructs and Adoption Intentions (continued)

The significant positive correlations between perceived usefulness (r = 0.64), perceived ease of use (r = 0.52), and adoption intentions validate TAM's applicability to cloud computing adoption in Nigerian academic library contexts. The regression analysis further confirms that both PU ($\beta = 0.58$, $p < 0.01$) and PEOU ($\beta = 0.45$, $p < 0.05$) significantly predict adoption intentions, collectively explaining 48% of variance.

The stronger predictive power of perceived usefulness compared to perceived ease of use aligns with findings from Somvir *et al*. (2024) in Indian libraries and Rachman (2020) in Indonesian contexts. This pattern suggests that when library professionals recognize clear benefits—such as data protection, disaster recovery capabilities, and service continuity—they express stronger adoption intentions despite concerns about implementation complexity.

The above-midpoint score for perceived usefulness (M = 3.85) indicates that FUE Zaria library staff generally recognize cloud computing's value for disaster management. This positive perception provides a favorable

foundation for adoption initiatives. However, the below-midpoint score for perceived ease of use (M = 2.95) reveals concerns about complexity, technical requirements, and implementation challenges that must be addressed through training and user-friendly system selection.

Oketch and Wamae (2021) documented a similar pattern at Egerton University, where high perceived usefulness (80% of staff) was offset by low perceived ease of use (70% found systems complex) due to inadequate training. This underscores that even when library professionals value technology benefits, adoption remains constrained without addressing usability concerns through comprehensive training programs and intuitive interface selection (Rachman, 2020).

The moderate R^2 value (0.48) suggests that while TAM constructs explain substantial variance in adoption intentions, additional factors—including institutional support, infrastructure quality, and financial resources—also influence adoption decisions. This finding supports Han's (2019) observation that organizational and contextual factors complement individual-level perceptions in determining technology adoption outcomes.

6.6. Challenges and Barriers to Adoption

The identification of high costs as the primary barrier (36%) aligns extensively with research on technology adoption in resource-constrained academic libraries (Patel & Sharma, 2021; Kumar *et al*., 2022; Akinola, 2022). Cloud computing subscription fees, infrastructure upgrade costs, and ongoing maintenance expenses exceed available budgets in many Nigerian institutions facing chronic underfunding (Akande *et al*., 2020). This financial barrier is particularly acute for comprehensive disaster management solutions requiring enterprise-level cloud services with guaranteed uptime, redundancy, and support.

The second-ranked challenge—lack of technical expertise (26%)—reflects persistent human capacity deficits in Nigerian academic libraries. Many library professionals lack formal training in cloud technologies, information systems management, and disaster recovery planning (Anasi & Ali, 2021; Rutto & Otike, 2016). This expertise gap constrains both initial implementation and ongoing system maintenance, creating dependencies on external consultants that institutions cannot afford.

Data security concerns (18%) represent legitimate anxieties about storing sensitive institutional data on external servers, particularly given Nigeria's evolving data protection regulatory framework and concerns about unauthorized access (Dada *et al*., 2025). While cloud providers typically implement robust security measures exceeding institutional on-site capabilities, perceptions of vulnerability persist, particularly among staff unfamiliar with cloud security architectures (Rachman, 2020).

Resistance to change (12%), while less prevalent, reflects organizational inertia and staff preferences for familiar traditional systems over unfamiliar technologies. Rogers (2003) documented that resistance typically diminishes through demonstration of clear benefits, peer influence, and successful implementation examples—strategies applicable at FUE Zaria.

Poor internet infrastructure (8%), while ranking lowest, represents a fundamental constraint in contexts with unreliable connectivity. Cloud computing requires consistent high-speed internet access; intermittent connectivity undermines system reliability and user confidence (Carter & Amlôt, 2022). However, the relatively low ranking may reflect recent infrastructure improvements in Zaria or respondents' focus on more immediate barriers like cost and expertise.

The mean challenge score of 3.70 (SD = 1.15) indicates moderately severe barriers requiring comprehensive, multi-dimensional interventions addressing financial, technical, security, and infrastructure constraints simultaneously rather than piecemeal approaches (Somvir *et al*., 2024).

6.7. Comparison with Similar Studies

The low adoption rates found at FUE Zaria (10% full, 20% partial) are consistent with patterns documented in comparable developing-country contexts. Rachman (2020) reported that only 25% of Indonesian academic libraries used cloud-based solutions, with none having comprehensive digital disaster plans. Oketch and Wa-

mae (2021) found that only 20% of Egerton University library staff regularly used backup systems and 15% used disaster monitoring tools.

However, FUE Zaria's adoption rates fall below those reported in some Indian contexts. Somvir *et al*. (2024) found that 60% of Indian libraries surveyed used cloud storage and 45% employed automated backup systems, though only 20% had comprehensive digital disaster plans. This suggests variation across developing contexts, potentially reflecting differences in institutional resources, government technology policies, and infrastructure development levels.

Compared to developed-country contexts, the gap is substantial. Veil and Bishop (2014) documented that U.S. libraries increasingly leverage cloud-hosted systems, with 90% service uptime maintained during disasters like Hurricane Florence. This disparity highlights how resource constraints and infrastructure limitations in Nigerian contexts fundamentally constrain technology implementation capacity.

The finding that awareness correlates significantly with adoption ($\chi^2 = 18.45$, $p < 0.01$) at FUE Zaria parallels Kumar *et al*.'s (2022) findings that awareness strongly predicts cloud technology adoption in disaster recovery contexts. Similarly, the predominance of cost (36%) and technical expertise (26%) as primary barriers aligns with Patel and Sharma's (2021) documentation of financial and capacity constraints as principal obstacles across developing-country library contexts.

6.8. Theoretical Implications

This study validates TAM's applicability to cloud computing adoption for disaster resilience in Nigerian academic library contexts. The significant predictive relationships between PU, PEOU, and adoption intentions ($R^2 = 0.48$) confirm that Davis's (1989) original model remains relevant across diverse cultural and institutional contexts. However, the moderate explanatory power suggests that TAM should be extended to incorporate contextual factors—including institutional support, infrastructure quality, financial resources, and organizational culture—that influence adoption in resource-constrained settings.

The significant association between awareness and adoption ($\chi^2 = 18.45$, $p < 0.01$) suggests that Rogers' (2003) Diffusion of Innovations framework complements TAM by highlighting the sequential innovation-decision process beginning with knowledge acquisition. Integrating these frameworks provides more comprehensive understanding of technology adoption dynamics in academic libraries.

The study also contributes to disaster resilience literature by documenting how technology adoption models apply specifically to disaster management contexts. The finding that perceived usefulness (centered on disaster protection benefits) more strongly predicts adoption intentions than perceived ease of use suggests that crisis-related applications may exhibit different adoption dynamics than general-purpose technologies.

6.9. Practical Implications

Findings provide several actionable insights for FUE Zaria and similar institutions:

1. **Awareness-building as foundation:** The significant awareness-adoption relationship indicates that comprehensive awareness campaigns, workshops, and training programs should constitute first-line interventions before major technology investments.

2. **Addressing cost barriers:** Given cost's predominance (36%), institutions should explore cost-reduction strategies including educational discounts, open-source alternatives, consortium arrangements for shared infrastructure, and phased implementation beginning with affordable entry-level services.

3. **Capacity building priority:** The technical expertise deficit (26%) necessitates systematic professional development programs, certifications, mentorship arrangements with experienced institutions, and potentially hiring specialized IT personnel.

4. **Security education:** Addressing data security concerns (18%) requires education about cloud security measures, regulatory compliance frameworks, and risk management strategies that often exceed on-site capabilities.

5. **Leveraging high perceived usefulness:** With PU scoring above midpoint (M = 3.85), institutions can build on existing recognition of cloud computing benefits through demonstration projects, success stories, and pilot implementations showcasing tangible disaster protection improvements.

6. **Improving perceived ease of use:** The below-midpoint PEOU score (M = 2.95) indicates need for user-friendly system selection, comprehensive training, ongoing technical support, and possibly engaging vendors offering intuitive interfaces designed for non-technical users.

7. Conclusion

This study investigated awareness, adoption patterns, and implementation challenges regarding cloud computing for disaster-resilient library management at the Federal University of Education, Zaria. Findings reveal critically low awareness levels (M = 2.60) and minimal adoption (70% no adoption, M = 1.40), with significant associations between awareness and adoption ($\chi^2 = 18.45$, $p < 0.01$). Technology Acceptance Model constructs—perceived usefulness ($\beta = 0.58$, $p < 0.01$) and perceived ease of use ($\beta = 0.45$, $p < 0.05$)—significantly predict adoption intentions, explaining 48% of variance. Principal barriers include high costs (36%), lack of technical expertise (26%), and data security concerns (18%).

These findings underscore substantial implementation gaps between cloud computing's recognized potential for enhancing library disaster resilience and actual deployment in resource-constrained Nigerian academic contexts. The study validates TAM's applicability while highlighting how contextual factors—infrastructure limitations, financial constraints, capacity deficits—fundamentally shape technology adoption dynamics in developing-country settings.

The research contributes to limited empirical literature on cloud computing adoption for disaster resilience in African academic libraries, providing evidence-based insights for policy development and strategic planning. By documenting specific awareness levels, adoption patterns, and barrier profiles, the study offers actionable intelligence for institutions seeking to enhance disaster preparedness through cloud-based solutions.

However, findings reveal that mere technology awareness, even when accompanied by positive utility perceptions, proves insufficient without addressing multifaceted barriers through comprehensive interventions encompassing training, infrastructure development, financial support, and institutional policy frameworks. The significant awareness-adoption relationship indicates that knowledge-building initiatives, while necessary, must be complemented by barrier-removal strategies for effective technology implementation.

7.1. Study Limitations

Several limitations constrain generalizability and interpretation:

1. **Geographic specificity:** Findings derive from a single institution (FUE Zaria), limiting generalizability to other Nigerian universities with different resource profiles, leadership priorities, or technological infrastructures.

2. **Small sample size:** While total enumeration of the 50-person population eliminates sampling error, the small absolute number limits statistical power for certain analyses and prevents complex multivariate modeling.

3. **Cross-sectional design:** Data collected at a single time point cannot establish causal relationships or document adoption trajectories over time.

4. **Self-reported data:** Questionnaire responses may reflect social desirability bias, particularly regarding awareness levels and adoption intentions, rather than actual behaviors.

5. **Limited TAM construct measurement:** While key TAM variables were measured, the study did not exhaustively assess all potential moderators (e.g., subjective norms, facilitating conditions) from extended TAM models.
6. **Absence of actual usage data:** The study measured adoption status and intentions but did not analyze actual system usage patterns, effectiveness, or user satisfaction among the small number of adopters.

8. Recommendations

Based on research findings, the following evidence-based recommendations are proposed:

8.1. For FUE Zaria Library Management

1. Implement Comprehensive Awareness and Training Programs

The library should develop and implement structured awareness campaigns and training workshops specifically addressing cloud computing fundamentals, disaster management applications, security measures, and implementation processes. These programs should target all staff levels, with differentiated content for technical personnel, librarians, and management. Training should emphasize practical demonstrations, success stories from comparable institutions, and hands-on experiences with user-friendly cloud platforms. Given the significant awareness-adoption relationship ($\chi^2 = 18.45$, $p < 0.01$), such initiatives constitute essential first steps toward enhanced adoption.

2. Adopt Phased Cloud Implementation Strategy

Rather than attempting comprehensive immediate migration, the library should implement cloud solutions incrementally, beginning with low-risk, non-confidential applications such as digital repositories, e-resources management, and institutional repositories. This phased approach allows staff to build confidence and technical competence while demonstrating tangible benefits before progressing to critical administrative systems. Pilot projects should be carefully evaluated for effectiveness, usability, and disaster recovery capabilities, with lessons learned informing subsequent phases.

3. Establish Cloud Adoption Policy Framework

FUE Zaria should develop comprehensive institutional policies governing cloud computing adoption, clearly specifying objectives, data management procedures, security protocols, roles and responsibilities, disaster recovery procedures, vendor selection criteria, and evaluation mechanisms. This policy framework should align with Nigerian data protection regulations, university strategic plans, and international best practices. Clear policies reduce uncertainty, provide implementation guidance, and ensure accountability.

4. Pursue Strategic Partnerships and Funding Sources

Given cost constraints (36% of respondents), the library should actively pursue partnerships with cloud service providers offering educational discounts (e.g., Microsoft Azure for Education, Google Cloud for Education), apply for technology grants from development agencies and foundations, explore consortium arrangements with other Nigerian universities for shared infrastructure costs, and advocate for increased budgetary allocations emphasizing cloud computing's strategic importance for institutional resilience.

8.2. For University Administration

5. Prioritize Infrastructure Development

University administration should invest in reliable internet connectivity, uninterrupted power supply systems (including solar alternatives), and modern computing equipment necessary for cloud platform access. Infrastructure limitations, while ranking lower (8%), represent fundamental prerequisites without which cloud computing remains impractical regardless of awareness or intentions.

6. Provide Institutional Support and Leadership

Given Han's (2019) finding that libraries with strong administrative backing were 40% more likely to adopt cloud solutions, FUE Zaria administration should publicly prioritize disaster resilience, allocate dedicated budgets for technology initiatives, include cloud adoption in strategic planning, recognize and reward innovation, and provide visible leadership support signaling organizational commitment.

8.3. For Nigerian Library Community

7. Develop National Guidelines and Standards

The Nigerian Library Association, Librarians' Registration Council of Nigeria, and National Universities Commission should collaboratively develop national guidelines for library disaster preparedness incorporating cloud computing best practices, establish minimum technology standards for academic libraries, create certification programs for disaster management specialists, and facilitate knowledge-sharing networks among institutions.

8. Establish Collaborative Networks

Nigerian academic libraries should form consortia for collective negotiation with cloud service providers, shared training programs, collaborative disaster recovery arrangements, and mutual technical support. Collaborative approaches reduce individual institutional costs and leverage collective bargaining power.

8.4. For Future Research

9. Conduct Longitudinal Studies

Future research should employ longitudinal designs tracking awareness, adoption, and outcomes over time to establish causal relationships and document implementation trajectories. Studies should examine whether awareness-building interventions successfully translate into adoption and whether adopted systems effectively enhance disaster resilience.

10. Expand Geographic and Institutional Scope

Research should extend to multiple Nigerian universities with diverse resource profiles, geographic locations, and institutional characteristics to establish generalizability and identify context-specific factors influencing adoption. Comparative studies across West African countries could identify regional patterns and transferable lessons.

11. Investigate Extended TAM Models

Future studies should incorporate additional constructs from extended TAM models—including subjective norms, facilitating conditions, anxiety, and self-efficacy—to enhance explanatory power beyond the 48% achieved in this study. Qualitative research could explore implementation processes, user experiences, and organizational dynamics in depth.

12. Evaluate Implementation Outcomes

Research should assess actual disaster resilience outcomes among institutions adopting cloud solutions, measuring recovery times, data loss prevention, service continuity, and user satisfaction. Such outcome evaluations would provide empirical evidence of cloud computing's effectiveness for library disaster management beyond perceptual measures.

9. Contributions to Knowledge

This study makes several significant contributions to library and information science scholarship:

1. **Empirical evidence from underrepresented context:** Provides rare quantitative data on cloud computing adoption in Nigerian academic libraries, addressing significant knowledge gaps in African library technology research.
2. **TAM validation in disaster management context:** Confirms Technology Acceptance Model's applicability to disaster resilience technologies, extending TAM literature beyond general-purpose applications.
3. **Awareness-adoption relationship documentation:** Establishes statistically significant associations between awareness levels and adoption status, empirically supporting awareness-building as foundational intervention strategy.
4. **Barrier profile identification:** Documents specific implementation challenges in resource-constrained contexts, providing actionable intelligence for policy development and strategic planning.
5. **Practical implementation framework:** Offers evidence-based recommendations integrating theoretical insights with practical constraints, creating actionable roadmap for institutions in similar contexts.

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