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Cloud Computing Adoption and Digital Archive Preservation in Academic Libraries: A Survey of Selected Institutions in Lagos and Ogun State, Nigeria

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Abstract
This study investigated the strategies and impact of cloud computing on preserving digital archives among library personnel in academic libraries in Lagos and Ogun States, Nigeria. The study adopted a descriptive survey research design. The population comprised 250 library personnel drawn from academic libraries in the two states, while a sample size of 152 respondents was selected using stratified random sampling technique. Data were collected through a structured questionnaire and analysed using descriptive statistics with the aid of IBM SPSS software. The findings revealed that cloud computing positively influences the preservation of digital archives by improving accessibility, enhancing security, and promoting cost-effectiveness. The study further showed that cloud computing facilitates collaboration, minimizes the risk of data loss, and simplifies the management of digital archives. Despite these benefits, challenges such as inadequate funding and shortage of trained personnel were identified. The study concluded that cloud computing offers substantial benefits for digital archive preservation in academic libraries, although deliberate strategic efforts are required to address the existing challenges. The study

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recommended increased funding for technological infrastructure, continuous staff training programmes, formulation of robust digital preservation policies, partnerships with cloud service providers, and regular evaluation of cloud computing solutions in academic libraries.

Keywords: Digital Archives, Impact of Cloud Computing, Strategies of Cloud Computing, Cloud Computing, Academic Libraries

Introduction

In the digital age, academic libraries are at the forefront of preserving knowledge and cultural heritage through digital archives. The advent of cloud computing has revolutionized the way these institutions manage, store, and preserve vast amounts of digital information. Cloud computing refers to the provision of diverse computing services over the internet, including servers, storage, databases, and software applications (Bisong, 2019; Bhambri et al., 2022). This technological advancement offers libraries the potential for enhanced scalability, accessibility, and cost efficiency, making cloud computing an indispensable tool for modern academic libraries (Singh, 2021).

The impact of cloud computing on the preservation of digital archives is profound. Cloud computing facilitates the long-term preservation of digital content by offering robust storage solutions and providing advanced tools for data management (Seth et al., 2022). These technologies enable libraries to maintain the integrity and accessibility of their digital collections over time, thus supporting research, teaching, and learning activities. Moreover, cloud computing allows for the seamless migration and backup of digital archives, mitigating risks of data loss and format obsolescence, which are critical for the sustainability of digital preservation efforts. The integration of cloud computing in digital archives has been explored in several studies. Sun (2021) and Masenya (2020) both highlight the potential of cloud computing in enhancing the preservation of digital resources, particularly in academic libraries.

However, Masenya (2020) also notes the low adoption of cloud computing in this context, particularly in South Africa, and recommends the development of preservation policies and technology infrastructure. Senthilkumar (2022) further emphasises the security benefits of cloud computing, particularly when combined with blockchain technology, in ensuring data immutability in digital archiving systems. In addition, cloud technologies have the potential to revolutionize cultural preservation and promotion by increasing accessibility, fostering collaboration, and reducing costs. The use of cloud-based systems can significantly contribute to the preservation of cultural identity and heritage for future generations. Cloud technologies also offer promising opportunities for enhancing the accessibility, collaboration, and cost-effectiveness of cultural heritage initiatives (Peteva, 2023). However, the journey to fully leverage cloud computing comes with its own set of challenges that need strategic addressingto ensure the security, integrity, and longevity of digital archives.

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The strategies for cloud computing adoption in university libraries is recommended, considering factors such as top management support, staff education, and environmental influences (Ibrahim, 2023). A roadmap for cloud computing adoption in academic libraries is proposed, emphasizing the need for preservation policies and technology infrastructure improvement (Masenya, 2021). The benefits of cloud computing in libraries are highlighted, along with security issues and measures to overcome them (Sinha, 2016). Despite the recognised benefits there is however limited study on how to strategically solve the problem of adoption of cloud computing for digital preservation in academic libraries particularly in Nigeria academic libraries. This study aims to address these gaps by exploring the strategies and impacts of cloud computing adoption on digital archive preservation in academic libraries within Lagos and Ogun State, Nigeria.

Statement of the Problem

The preservation of digital archives is a critical function of academic libraries, ensuring that valuable digital content remains accessible and usable for future generations. However, the adoption of cloud computing, which holds significant promise for enhancing the management and preservation of these digital assets, presents several challenges that need to be strategically addressed. Academic libraries, particularly in regions such as Lagos and Ogun State, Nigeria, face substantial obstacles, including insufficient funding, lack of trained personnel, and rapidly evolving technological landscapes. Despite the recognised benefits of cloud computing in terms of scalability, cost efficiency, and data redundancy, many libraries struggle to implement and maintain effective cloud-based digital preservation solutions. Therefore, this study seeks to address this problem by exploring effective strategies for overcoming the challenges associated with cloud computing adoption and assessing its impact on the preservation of digital archives in academic libraries within Lagos and Ogun State, Nigeria.

Research Objective

The main objective of this study is to investigate the strategies and impact of cloud computing in preserving digital archives in libraries. The specific objective of this study is to;

1. Examine how cloud computing enhances digital archives management in selected academic libraries in Lagos and Ogun State.
2. Explore potential strategies to overcome the challenges of cloud computing in preserving digital archives in the selected academic libraries in Lagos and Ogun State.
3. Examine the prevalence preservation of digital archives in the selected academic libraries in Lagos and Ogun State.
4. Establish the influence of cloud computing on preservation of digital archives in the selected academic libraries in Lagos and Ogun State.

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Literature Review

Impact of Cloud Computing in Preserving Digital Archives in Libraries

The advent of cloud computing has brought transformative changes to various sectors, including academic libraries, particularly in the preservation of digital archives. Cloud computing significantly enhances the accessibility of digital archives, allowing users to access information from any location with internet connectivity. This ubiquitous access is particularly beneficial for academic libraries, where researchers and students require seamless access to resources for study and research purposes. Ruest (2020) emphasised that cloud technologies facilitate better accessibility and sharing of digital archives, enabling libraries to serve a broader user base efficiently. Similarly, Panda et al. (2024) noted that cloud computing supports collaborative efforts among libraries, allowing them to share resources and expertise more effectively. Furthermore, Bharany et al. (2022) highlighted the economic advantages of cloud solutions, stating that they offer significant savings in terms of hardware, maintenance, and energy costs. This implies that when libraries leverage on cloud computing technology, they can avoid the substantial capital expenditure associated with maintaining physical servers and storage systems. According to Senthilkumar (2022), cloud service providers implement robust security measures that often exceed the capabilities of individual libraries, thereby enhancing the overall security of digital archives.

Prevalence of the Preserving of Digital Archives in Libraries

The preservation of digital archives in academic libraries has become increasingly prevalent as institutions recognize the importance of safeguarding valuable digital content for future generations (Kar and Mallik, 2024). This recognition is driven by the growing reliance on digital resources for research, teaching, and learning, as well as the need to comply with funding requirements and open access mandates. As a result, academic libraries are investing in technologies and strategies to ensure the long-term preservation of digital archives, including implementing digital preservation systems, establishing metadata standards, and conducting regular data migration and backups (Masenya & Ngulube, 2019).

Moreover, academic libraries are also actively collaborating with other institutions and organizations to share best practices and develop preservation guidelines. This collaborative approach is crucial as it enables academic libraries to address the unique challenges associated with the preservation of digital archives, such as format obsolescence, data loss, and technological advancements. In addition to technological investments and collaborations, academic libraries are also emphasizing the training and professional development of their staff in the field of digital preservation. This ensures that the libraries have the necessary expertise and skills to effectively manage and preserve digital archives. Moreover, many libraries are actively engaging in outreach and education efforts to raise awareness about the importance of digital preservation among faculty, students, and other stakeholders.

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Furthermore, the preservation of digital archives in academic libraries is not only about safeguarding the content but also ensuring its accessibility and usability over time (Masenya, & Ngulube, 2021). Therefore, libraries are making efforts to implement user-friendly access systems and tools, as well as to conduct regular assessments and audits to monitor the integrity and authenticity of the digital collections. As the landscape of digital resources continues to evolve, academic libraries are constantly adapting their preservation strategies to keep pace with the latest developments and best practices in the field. This ongoing commitment to the preservation of digital archives underscores the libraries' dedication to serving as custodians of knowledge and cultural heritage in the digital age.

Strategies to overcome the challenges of Cloud Computing in Libraries

Cloud computing has been increasingly adopted by academic libraries to support their information technology infrastructure and services (Anna & Mannan, 2020). However, there are several challenges that need to be addressed in order to maximize the benefits of cloud computing in academic libraries. One strategy to overcome these challenges is the implementation of evaluation mechanisms to continuously assess the performance of cloud computing solutions. This can include regularly monitoring and analyzing key performance indicators such as uptime, response time, and overall system availability. Through regularly reviewing and updating cloud computing policies, academic libraries can adapt to evolving technology and organizational needs (Jahangiri, Saberi & Vakilimofrad, 2021). This can involve conducting regular assessments and audits of cloud computing services to ensure they align with the library's goals and objectives. Another strategy is fostering partnerships and collaborations with reputable cloud service providers. This can help academic libraries leverage the expertise and experience of these providers to address the challenges of cloud computing. These partnerships can provide access to specialized support and training, as well as ensure compliance with data security and privacy regulations.

Furthermore, academic libraries can also consider implementing a multi-cloud approach, where they utilise multiple cloud service providers to mitigate risks and ensure redundancy. This approach can provide additional flexibility and resilience in the face of potential service disruptions or data loss. Additionally, to improve facilitate successful adoption, academic libraries can implement various strategies. These include investing in staff training and development programs, establishing cross-departmental collaborations, and leveraging professional networks and consortia to share best practices and resources (Ali et al., 2020). Additionally, proactive engagement with cloud service providers and industry experts can help libraries stay informed about emerging trends and technologies (Lippincott, 2021).

Methodology

The descriptive survey research design was used for this study. The population of the study comprised 250 library personnel working in academic libraries in Lagos and Ogun States, Nigeria. The population size for each category of institution was obtained through

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institutional records and professional contacts with library colleagues in the respective universities, due to the absence of a centralized database of library personnel. Krejcie and Morgan (1970) formula was used to arrive at the sample size of 152. Stratified random sampling technique was used to select respondents and a self-structured questionnaire tilted questionnaire on Impact and Strategies of cloud computing in preserving digital archives (ISCCPDA) was used to elicit responses from library personnel. The questionnaire was divided into four sections which include demographic information (Section A), Impact of cloud computing (section B), Prevalence of Preservation of digital archives in academic library (section C) and the strategies of overcoming the challenges of cloud computing in preserving digital archives the libraries (section D). The instrument was subjected to face and content validity by experts in Library and Information Science and research methodology to ensure clarity, relevance, and appropriateness of the items. Their observations and suggestions were incorporated into the final version of the questionnaire. To ascertain the reliability of the instrument, a pilot study was conducted using library personnel at Kenneth Dike Library, Univesity of Ibadan, Oyo State, Nigeria, obtaining thirty (30) responses. The data obtained were analysed using Cronbach's Alpha reliability method. The reliability coefficients obtained for Sections B, C, and D were 0.81, 0.78, and 0.84 respectively. A total of 152 copies of the questionnaire were administered and 123 (80.9%) were retrieved and deemed fit for analysis. Frequency counts, mean, simple percentages and standard deviation were used to analyse the research questions, with the aid of IBM Statistical Package for Social Sciences (IBM SPSS) version 26 software.

Result Presentation and Interpretation

Demographic Information of Respondents

The findings revealed that the majority of participants were information professionals from Olabisi Onabanjo University library (47.4%), while the fewest respondents were from Lazoti Library at Babcock University (24.9%). The gender distribution indicates a higher proportion of female library personnel (61.8%) compared to male personnel (38.2%). Additionally, the largest percentage of respondents are aged 31 and above, whereas the smallest group falls within the 21-25 age range. Furthermore, 71.5% of respondents have over 16 years of service, representing the highest category, while only 5.7% have between 1-5 years of service, the lowest category. Lastly, library officers constitute the largest group of respondents at 78.0%, while professional librarians are the smallest group at 22.0%.

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Table 1: How cloud computing enhances Digital Archives Management in Libraries

Cloud Computing:	Strongly Agree	Agree	Disagree	Strongly Disagree	Mean	SD
Improves the accessibility of digital archives in our library	78 (63.4%)	44 (35.7%)	1 (0.8%)	0 (0%)	3.62	.334
Enhance the security of digital archives in our library	69 (56.1%)	52 (42.3%)	2 (1.6%)	0 (0%)	3.54	.406
Are cost-effective for preserving digital archives in our library	89 (72.4%)	32 (26.0%)	2 (1.6%)	0 (0%)	3.70	.726
The scalability of cloud computing meets the growing storage needs of our digital archives	56 (45.5%)	67 (54.5%)	0 (0%)	0 (0%)	3.45	.538
Reduce the risk of data loss for our digital archives	73 (59.3%)	49 (39.8%)	1 (0.8%)	0 (0%)	3.58	.777
Enable better collaboration and sharing of digital archives with our library network	97 (78.9%)	25 (20.3%)	1 (0.8%)	0 (0%)	3.78	.577
Simplifies the process of managing digital archives in our library	98 (79.6%)	25 (20.3%)	0 (0%)	0 (0%)	3.79	.872

Decision Rule: if mean is 1-1.74 = Strongly Disagree 1.75 – 2.49= Disagree, 2.50 – 3.24 = Agree, 3.25 – 4.00 = Strongly Agree

Table 1 presents the impact of cloud computing in preserving digital archives. The results indicate that respondents strongly agree on the positive impact of cloud computing in preserving digital archives within libraries. Specifically, cloud computing is seen to improve accessibility ($\bar{X}$= 3.62), enhance security ($\bar{X}$= 3.54), and be cost-effective ($\bar{X}$= 3.70). The scalability of cloud computing meets the growing storage needs ($\bar{X}$= 3.45), and it significantly reduces the risk of data loss ($\bar{X}$= 3.58). Furthermore, cloud computing enables better collaboration and sharing of digital archives ($\bar{X}$= 3.78) and simplifies the process of managing digital archives ($\bar{X}$= 3.79). These findings suggest that cloud computing is highly beneficial for digital archive preservation, offering improvements in accessibility, security, cost-effectiveness, scalability, data loss prevention, collaboration, and management efficiency.

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Table 2: Prevalence of Preservation of Digital Archives in Libraries

Items	Strongly Agree	Agree	Disagree	Strongly Disagree	Mean	SD
Digital preservation is a top priority for our library's long-term collection management strategy.	63 (51.2%)	42 (34.1%)	10 (8.1%)	8 (6.5%)	3.30	.877
Our library has sufficient funding allocated specifically for the preservation of digital archives.	17 (13.8%)	11 (8.9%)	9 (7.3)	86 (69.9%)	1.67	1.11
The current preservation standards and practices for digital archives are consistently effective across our library system.	49 (39.8%)	55 (44.7%)	18 (14.6%)	1 (0.8%)	3.24	.725
The training opportunities provided to library staff addresses the complexities of digital preservation.	16 (13.0%)	14 (11.4%)	84 (68.3%)	9 (7.3%)	2.30	.789
The library administration demonstrates a strong commitment to ensuring the accessibility and usability of preserved digital archives for future generations.	23 (18.7%)	20 (16.3%)	69 (56.1%)	11 (8.9%)	2.45	.898

Decision Rule: if mean is 1-1.74 = Strongly Disagree 1.75 – 2.49= Disagree, 2.50 – 3.24 = Agree, 3.25 – 4.00 = Strongly Agree

Table 2 presents the prevalence of preservation of digital archives in selected academic libraries, Lagos and Ogun State. The results indicate varied levels of agreement on prevalence of digital archive preservation in libraries. Digital preservation being a top priority for long-term collection management strategy is agreed upon by respondents ($\bar{X}$= 3.30). However, there is strong disagreement that libraries have sufficient funding allocated for digital archive preservation ($\bar{X}$= 1.67). The effectiveness of current preservation standards and practices is agreed upon ($\bar{X}$= 3.24), while there is disagreement on the adequacy of training opportunities provided to library staff ($\bar{X}$= 2.30). Additionally, there is a disagreement regarding the library administration's commitment to ensuring the accessibility and usability of preserved digital archives ($\bar{X}$= 2.45). The findings suggest that while digital preservation is prioritised and current practices are somewhat effective, there are significant concerns regarding funding, training, coupled with the support from the library administration.

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Table 3: Strategies to overcome challenges of cloud computing in preserving digital archives within libraries

Items	Strongly Agree	Agree	Disagree	Strongly Disagree	Mean	SD
Implementation of evaluation mechanisms to continuously assess the performance, security, and effectiveness of cloud computing solutions for preserving digital archives	111 (90.2%)	11 (8.9%)	1 (0.8%)	0 (0%)	3.89	.334
Regularly review and update of cloud computing policies to adapt to evolving technology and organizational needs	106 (86.2%)	15 (12.2%)	2 (1.6%)	0 (0%)	3.85	.406
Develop and implement robust mitigation plans to ensure data security and integrity.	68 (55.3%)	44 (35.8%)	8 (6.5%)	3 (2.4%)	3.44	.726
Development of clear and comprehensive policies governing the preservation of digital archives in the cloud regarding data access and rights usage, data retention.	51 (41.5%)	69 (56.1%)	3 (2.4%)	0 (0%)	3.39	.538
Provide training programs and capacity-building initiatives to library staff to enhance their understanding of cloud computing technologies.	63 (51.2%)	41 (33.3%)	17 (13.8%)	2 (1.6%)	3.34	.777
Foster partnerships and collaborations with reputable cloud service providers to leverage their expertise	46 (37.4%)	70 (56.9%)	7 (5.7%)	0 (0%)	3.32	.577

Decision Rule: if mean is 1-1.74 = Strongly Disagree 1.75 – 2.49= Disagree, 2.50 – 3.24 = Agree, 3.25 – 4.00 = Strongly Agree

Table 3 presents the Strategies to overcome challenges of cloud computing in preserving digital archives within libraries. The results indicate that respondents strongly agree on several key strategies for overcoming challenges in cloud computing for digital archive preservation. The highest agreement was for the implementation of continuous evaluation mechanisms to assess performance, security, and effectiveness ($\bar{X}$= 3.89). This is followed closely by the need for regularly reviewing and updating cloud computing policies to adapt to evolving technology and organizational needs ($\bar{X}$= 3.85), highlighting their importance in maintaining the performance, security, and effectiveness of cloud computing solutions. Additionally, there is strong agreement on developing and implementing robust mitigation

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plans to ensure data security and integrity ($\bar{X}$= 3.44). However, the development of clear policies for data access, rights usage, and data retention ($\bar{X}$= 3.39), providing training programs for library staff ($\bar{X}$= 3.34), and fostering partnerships with reputable cloud service providers ($\bar{X}$= 3.32) also received significant support, though not strongly agreed upon, indicating these are also important but slightly less emphasised strategies.

Table 4: Regression Analysis of the Influence of Cloud Computing on Preservation of Digital Archives in Academic Libraries

Variables	B	*β*	*T*	*Sig.*	R^2	*Adj.* R^2	*F(df)*	*ANOVA (Sig.)*
(Constant)	-.280		-1.354	.178	.622	.619	199.336	<.001[b]
Cloud Computing	.831	.789	14.119	<.001				

Dependent Variable: Preservation of Digital Archives *Note: β= Standardized Coefficient, significant at 0.05*

Table 4 presents the linear regression analysis of the influence of cloud computing on the preservation of digital archives in selected academic libraries in Lagos and Ogun States, Nigeria. The findings revealed that cloud computing significantly influences the preservation of digital archives (Adj. R^2 = .619, F(1,121) = 199.336, p < 0.05). This indicates that cloud computing accounts for approximately 61.9% of the variance in digital archive preservation among the selected libraries. The standardized regression coefficient (β = .789) further indicates a strong positive relationship between cloud computing and the preservation of digital archives. Consequently, the null hypothesis stating that cloud computing has no significant influence on the preservation of digital archives in selected academic libraries in Lagos and Ogun States, Nigeria, was rejected. The study therefore concludes that cloud computing significantly enhances the preservation of digital archives in the selected academic libraries.

Discussion of Findings

The study revealed several strategies to overcome the challenges of cloud computing in preserving digital archives within libraries. The most prominent strategy is the implementation of evaluation mechanisms to assess the performance, security, and effectiveness of cloud computing solutions continuously. Additionally, regularly reviewing and updating cloud computing policies and fostering partnerships with reputable cloud service providers are also suggested strategies. In the same vein, Ali, Wood-Harper and Ramlogan (2020) concurred that the strategies to overcome the problem faced in the adoption of cloud

computing, there is a need for collaboration with cloud service providers' capability and skills to effectively manage institutional data.

The findings of this study also underscore the significant positive impact of cloud computing on preserving digital archives in academic libraries, as respondents overwhelmingly agreed on its benefits. Specifically, cloud computing was found to enhance the accessibility and security of digital archives, align with cost-effective practices and meet the growing storage needs through scalability. Additionally, it reduces the risk of data loss, facilitates better collaboration and sharing within library networks, and simplifies the management of digital archives. These findings are supported by previous research, such as that by Senthilkumar (2022), who highlighted the cost-effectiveness and scalability of cloud solutions in digital preservation, and (Peteva, 2023) who emphasised the enhanced accessibility and security provided by cloud technologies in archival contexts. Moreover, Sun (2021) corroborated the reduced risk of data loss and improved management capabilities associated with cloud computing in digital archives. Together, these studies and the current findings illustrate the pivotal role of cloud computing in modernizing and safeguarding digital archival practices.

Furthermore, the study revealed the prevalence of preservation of digital archives in selected academic libraries in Lagos and Ogun State. The respondents agree to the facts that digital preservation is a top priority for their library's long-term collection management strategy, and the current preservation standards and practices for digital archives are consistently effective across their library systems. However, the result obviously reveals that libraries have no sufficient funding allocated specifically for the preservation of digital archives. This finding is supported by Masenya and Ngulube (2019) who revealed that academic libraries experienced difficulties in preserving and sustaining their digital archives because of the absence of established standards, policies and procedures, inadequate resources, as well as a lack of skills and training. They also had difficulties with limited funding and collaboration efforts.

Finally, the findings of the study revealed that there is a strong positive significant influence of cloud computing technology in preserving digital archives in academic libraries with a significant level less than 0.05. This finding is supported by Jalamneh and Khder (2021) who reported their findings that cloud computing exerted a huge influence on various institutional digital resources including digital archives. This influence rage from preservation, easy accessibility, cost- effective, security against data loss etc.

Conclusion

The study concludes that cloud computing significantly enhances the preservation of digital archives in academic libraries in Lagos and Ogun States, Nigeria. The findings reveal that cloud computing improves accessibility, security, and cost-effectiveness while reducing the risk of data loss and facilitating better collaboration and management of digital archives.

However, challenges such as insufficient funding, lack of trained personnel, and the need for robust mitigation plans and policy frameworks must be addressed to fully leverage the benefits of cloud computing in digital preservation.

Recommendations

The following recommendations were made based on the findings of this study:

1. The library management should ensure sufficient allocation of resources specifically for cloud computing initiatives to ensure sustainable digital archive preservation.
2. The library management should implement comprehensive training programs to equip library staff with the necessary skills and knowledge to effectively use cloud computing technologies.
3. Libraries should development and regularly update of policies governing the use of cloud computing in digital preservation to address evolving technological and organizational needs.
4. The library should foster collaborations with reputable cloud service providers to leverage their expertise and ensure compliance with data security and privacy regulations.

Limitations of the Study

This study has certain limitations that should be acknowledged. The study was restricted to academic libraries in Lagos and Ogun States, Nigeria, which may limit the generalisability of the findings to other geopolitical regions with different institutional and technological contexts. Although the sample size of 123 valid responses was considered adequate for statistical analysis, it may still limit the extent to which the findings can be generalized to the entire population of academic library personnel in Nigeria. While population figures were obtained through institutional records and professional contacts across the selected universities due to the absence of a centralized database of library personnel, this approach may have introduced minor inconsistencies in population estimation. Despite these limitations, the study provides useful empirical insights into the impact of cloud computing on the preservation of digital archives and strategies for addressing related challenges in academic libraries.

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