IMPACT OF EMERGING TECHNOLOGIES ON OPEN ACCESS (OA) IN THE FIFTH INDUSTRIAL REVOLUTION (5IR): A STUDY OF SELECTED PRIVATE UNIVERSITY LIBRARIES IN SOUTH-WEST, NIGERIA

By

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Abstract

This study investigated the impact of emerging technologies, specifically Artificial Intelligence (AI), blockchain, cloud computing, and institutional repositories, on Open Access (OA) practices within the framework of the Fifth Industrial Revolution (5IR). The research explores the levels of awareness, adoption, perceived benefits, alignment with 5IR principles, and challenges faced in implementing OA technologies. A descriptive survey research design, 120 library personnel, including librarians, system librarians, and library officers from 17 private university libraries in South-west, Nigeria and a structured online questionnaire was adopted. The findings revealed high awareness and moderate adoption of institutional repositories and cloud computing, while blockchain and AI for OA remain less familiar and underutilised. Respondents perceived emerging technologies as beneficial to OA, particularly in improving research discoverability, efficiency, and visibility. The major challenges were: inadequate funding ($\bar{x}$ = 2.96), poor digital infrastructure ($\bar{x}$ = 2.85), and low technical skills. There was a strong alignment between OA practices and 5IR values: ethics ($\bar{x}$ = 2.94), sustainability ($\bar{x}$ =2.90), and social good ($\bar{x}$=2.85). Therefore, increased budget allocation, institutional policy reform, staff training, and strategic partnerships were recommended.

Keywords: Open Access, Emerging Technologies, Fifth Industrial Revolution, University Libraries, Nigeria

Introduction

The global field of scholarly communication is experiencing rapid transformation driven by the advancement of emerging technologies and the growing movement for Open Access (OA) to academic knowledge. Open access, which enables unrestricted online access to scholarly outputs, has gained momentum as a means of promoting equity in research dissemination, especially in low- and middle-income countries (Suber, 2012; Chan et al., 2011). This shift aligns closely with the unfolding Fifth Industrial Revolution (5IR); a new industrial era characterised not just by technological innovation, but by the ethical, inclusive, and human-centered integration of such technologies (Schwab, 2019; Sadar et al., 2021). Unlike the Fourth Industrial Revolution (4IR), which emphasised automation and efficiency, 5IR prioritises the synergy between humans and machines in ways that foster sustainability, compassion, and social good (Iyamu & Nunu, 2023). In the context of academia, 5IR offers a framework for advancing OA practices through the adoption of technologies such as artificial intelligence (AI), blockchain, cloud computing, and institutional repositories, while maintaining ethical and equitable principles (Peters et al., 2020).

In Nigeria, the adoption of emerging technologies for OA in universities is still at a nascent stage. While some progress has been made through institutional repositories and digitisation projects, numerous barriers hinder widespread adoption. These include limited funding, inadequate digital infrastructure, insufficient technical expertise, and low levels of awareness among academic staff and stakeholders (Aguolu & Aguolu, 2020; Esema, 2023; Fatoki, 2020). Consequently, Nigerian universities often struggle to align with global OA initiatives, leaving gaps in the accessibility and visibility of African scholarship.

This study therefore, investigates the role of emerging technologies in advancing Open Access in four selected Nigerian universities, framed within the values and vision of the Fifth Industrial Revolution. By surveying academic stakeholders from eighteen private universities, the research aims to assess levels of awareness, adoption, perceived benefits, and challenges associated with integrating these technologies. In doing so, it seeks to determine the extent to which institutions align with 5IR values and propose actionable strategies for fostering ethical and sustainable OA practices. Ultimately, the study contributes to existing scholarship by highlighting the potential of emerging technologies to transform knowledge dissemination in developing contexts, and by offering practical recommendations for building more inclusive and sustainable knowledge ecosystems (Mchaney et al., 2022; Okike & Adetoro, 2021).

Statement of the Problem

Open Access (OA) has emerged as a powerful tool for democratising knowledge, promoting academic visibility, and reducing barriers to scholarly communication. Globally, the integration of emerging technologies—such as artificial intelligence, blockchain, cloud computing, and institutional repositories—has significantly enhanced the effectiveness of OA by improving discoverability, transparency, and long-term preservation of research outputs (Otubelu & Chukwueke, 2023; Mchaney et al., 2022). However, in Nigerian universities, the integration of these technologies into OA systems remains limited. Several challenges persist, including inadequate funding, poor digital infrastructure, limited technical expertise, and low awareness of OA technologies among stakeholders (Esema, 2020; Ese & Ese, 2021). Moreover, institutional policies that promote OA and digital innovation are often inefficient or underdeveloped, hindering progress and limiting the global visibility of Nigerian scholarship.

Although prior studies have examined general awareness and usage of OA in Nigerian academic settings, few have focused on how emerging technologies are being adopted within the framework of the Fifth Industrial Revolution (5IR)—which emphasises ethical, inclusive, and human-centered technology use (Agu & Usoigwe, 2023; Schwab, 2019). This gap in the literature necessitates a focused investigation into the alignment of Nigerian universities' OA practices with 5IR principles. This study seeks to address this need by evaluating the extent of awareness and adoption of emerging technologies, identifying key barriers to implementation, and proposing strategic approaches to strengthen OA through the lens of 5IR values. The findings are expected to inform policy and practice, fostering a more sustainable, ethical, and inclusive academic environment in Nigerian higher education.

Research Objectives and Questions

The primary purpose of this study was to investigate the impact of emerging technologies—specifically Artificial Intelligence (AI), blockchain, cloud computing, and institutional repositories on Open Access (OA) practices in university libraries in South-West Nigeria within the framework of the Fifth Industrial Revolution (5IR). This fundamental objective was modified into research questions and answered in this study. The research questions were:

1. What is the level of awareness of emerging technologies for Open Access (OA) among library personnel in universities in South-West Nigeria?

2. To what extent have emerging techn ologies such as AI, blockchain, cloud computing, and institutional repositories been adopted for Open Access in the selected universities?
3. What are the perceived benefits and alignment of Open Access technologies with the principles of the Fifth Industrial Revolution (5IR) in university library practices?
4. What are the major barriers and effective implementation strategies for adopting emerging technologies for Open Access in Nigerian university libraries?

Literature Review

Concept of Open Access (OA)

A foundational understanding of Open Access (OA) is central to librarians' awareness of emerging technologies. Recent scholarship emphasises OA as a mechanism for equitable scholarly communication. For example, studies highlight that OA policies increasingly promote free and immediate access as a core principle in institutional missions (Evaluating the Impact of OA Policies, 2020). In exploring OA models, Green OA allows low-cost self-archiving, Gold OA enhances visibility but imposes APCs, and Hybrid OA combines subscription and open access, raising equity concerns (Okike & Adetoro, 2021; Tenopir et al., 2017). Understanding these OA models is critical because they shape how librarians approach technology decisions for discovery and accessibility. Nigerian and African studies contextualize these models within equity and policy discourse, positioning OA as a public good that requires active institutional engagement (Esema, 2020; Fatoki, 2020; Agu & Usoigwe, 2023). In this way, conceptual clarity about OA creates the foundation for awareness of relevant technologies.

Empirical research reveals varied levels of OA awareness among academic librarians, especially in Nigeria. According to Esema (2020) and Fatoki (2020), many librarians lack sufficient awareness of OA principles and institutional policies, indicating a foundational gap. Further investigations report that limited understanding of repository operations and OA models such as Green, Gold, and Hybrid is common, contributing to underutilization of institutional repositories (Agu & Usoigwe, 2023; Mchaney et al., 2022; Okike & Adetoro, 2021). At the continental level, the African Library & Information Associations and Institutions [AfLIA] (2021) notes that participation in OA Week campaigns and surveys has improved awareness incrementally, yet gaps remain in practical knowledge of OA tools. Subsequent work by AfLIA (2024) also observes that public and academic libraries in South Africa have begun integrating OA practices, but knowledge of emerging OA technologies varies significantly. These findings

suggest that while awareness initiatives are useful, substantial knowledge and familiarity gaps still persist in academic libraries across Nigeria and Africa.

Adoption of Emerging Technologies for Open Access

The adoption of emerging technologies for Open Access (OA) has become a focal point in global scholarly communication, offering innovative tools for enhancing research accessibility, visibility, and preservation. Artificial Intelligence (AI), for instance, has been widely acknowledged as a game changer in metadata generation, intelligent discovery tools, and workflow automation in OA repositories. According to Otubelu and Chukwueke (2023), AI-powered indexing and recommendation systems significantly improve the discoverability of scholarly outputs by generating richer metadata and streamlining retrieval processes. Similarly, Tella, Ogunsola, and Adekoya (2023) emphasise that AI-assisted curation enables libraries to manage vast OA collections with greater precision and reduced manual effort.

Beyond AI, blockchain technology is increasingly recognised for its role in enhancing security, verifying authorship, and combating predatory publishing. As Otubelu and Chukwueke (2023) observe, blockchain's immutable ledger provides a trusted record of publication provenance, thereby discouraging fraudulent practices. Onifade and Okunlola (2023) further argue that blockchain integration in OA ensures transparent peer review and rights management, though its implementation in Nigeria remains at a conceptual stage. Equally important is cloud computing, which provides scalable, secure, and cost-efficient infrastructure for hosting OA platforms.

Ese and Ese (2021) point out that cloud-based OA systems enable remote access and collaborative research, while also supporting disaster recovery, a feature essential in regions with unstable power supply. Finally, institutional repositories (IRs) continue to be the most entrenched OA technology in Nigerian universities, serving as central archives for theses, dissertations, and faculty publications (Okike & Adetoro, 2021; Yusuf, Oyeniran, & Adewale, 2024). As such, each of these technologies addresses different but complementary needs within the OA ecosystem.

When viewed through a comparative lens, adoption trends reveal a pronounced disparity between global and Nigerian contexts. Internationally, AI, blockchain, and cloud computing are being integrated at scale into OA platforms, as shown by Mchaney, Owolabi, and Maluleke (2022), who report successful deployments in South Africa's open science networks and Europe's Horizon 2020 projects. Likewise, Calvo, Delgado, and Stone (2020) note that European

academic networks have embraced blockchain-based authorship verification systems alongside AI-enhanced metadata management. However, in Nigeria, adoption levels vary sharply across technologies.

Institutional repositories and cloud computing have achieved moderate uptake, often driven by donor-funded digitisation projects (Esema, 2020; Agu & Usoigwe, 2023). By contrast, AI and blockchain remain underutilised due to a combination of technical skill shortages, infrastructural deficits, and limited awareness (Onifade & Okunlola, 2023; Fatokun & Ajegbomogun, 2023). Lawal and Okiki (2023) contend that while Nigerian private universities show more flexibility in adopting cloud-based OA systems, the pace of integrating AI and blockchain is hindered by a lack of dedicated policy frameworks and insufficient investment in emerging technology infrastructure. This disparity highlights the importance of benchmarking Nigerian OA practices against international best practices to identify scalable models for technology adoption.

Several interrelated factors shape the extent to which emerging technologies are adopted for OA in Nigeria. Institutional readiness is perhaps the most critical, encompassing leadership commitment, policy support, and organisational culture. Adeleke, Olatunji, and Olorunsola (2023) highlight that institutions with proactive leadership and dedicated digital strategies tend to implement OA technologies more effectively. Infrastructure is another determinant, as poor internet connectivity and unreliable power supply continue to impede consistent use of cloud and AI services (Ese & Ese, 2021; Dow, 2025). Funding limitations also play a decisive role; Fatoki (2020) observes that budgetary constraints force many institutions to prioritise basic operations over technology investments. Moreover, technical skills and training directly influence adoption rates — without regular capacity-building, staff may find AI tools or blockchain platforms too complex to operate (Omotade & Akinola, 2025; Imam, Okoro, & Ilori, 2024). Finally, collaboration and partnerships emerge as enablers; as Mchaney et al. (2022) note, alliances between universities, technology firms, and international networks can provide access to both expertise and funding. Collectively, these factors illustrate that adoption is not merely a question of technological availability but a multifaceted process shaped by organisational, infrastructural, and human capacity dynamics.

Perceived Benefits and Alignment with Fifth Industrial Revolution (5IR) Principles

The Fifth Industrial Revolution (5IR) represents a significant shift from the automation-driven focus of the Fourth Industrial Revolution to an approach that emphasises ethical, human-centred, inclusive, and sustainable integration of technology. Schwab (2019) explains that while the Fourth Industrial Revolution prioritised efficiency and advanced automation, the 5IR seeks to place human values, equity, and creativity at the heart of technological innovation. Iyamu and Nunu (2023) further note that the 5IR promotes a symbiotic relationship between human intelligence and machine capabilities, ensuring that technological systems advance social good rather than exacerbate inequalities.

In the context of academic libraries, Peters, Besley, and Jandrić (2020) argue that this paradigm offers opportunities for reimagining Open Access not merely as a dissemination model but as a catalyst for ethical knowledge sharing. By embedding inclusivity and sustainability into OA technology design, universities can create scholarly ecosystems that serve both local and global communities. This vision aligns with the study's focus on understanding how emerging technologies in OA can advance equitable access to knowledge while respecting the ethical imperatives of the 5IR.

Emerging technologies offer a wide range of benefits for OA that resonate with the core principles of the 5IR. According to Otubelu and Chukwueke (2023), AI-powered indexing and discovery tools improve the discoverability of research outputs, enabling researchers and the public to access relevant content quickly and accurately. Similarly, blockchain technologies enhance visibility and trust by ensuring the authenticity of scholarly records and preventing tampering, as observed by Onifade and Okunlola (2023). Cloud computing, as noted by Ese and Ese (2021), expands accessibility by providing scalable infrastructure that allows institutions to host vast OA collections without significant upfront investment. Institutional repositories also contribute to long-term preservation, ensuring that scholarly works remain accessible to future generations, as highlighted by Okike and Adetoro (2021) and Yusuf, Oyeniran, and Adewale (2024). The combined effect of these benefits is an OA environment that fosters collaboration, enhances the visibility of local research, and reduces the knowledge divide between developed and developing contexts.

Several case examples illustrate how OA technologies can achieve 5IR-aligned outcomes in academic libraries. Mchaney, Owolabi, and Maluleke (2022) describe how South African universities have integrated AI-driven metadata systems and blockchain verification processes to

improve both discoverability and trust in scholarly publishing. In Europe, Calvo, Delgado, and Stone (2020) report on collaborative OA networks that employ cloud-based platforms to enable cross-border research while ensuring equitable access for institutions with limited resources. Within Nigeria, Agu and Usoigwe (2023) highlight initiatives where institutional repositories, supported by cloud infrastructure, have improved the accessibility of indigenous research while aligning with sustainability goals by reducing reliance on physical archives. These examples demonstrate that when OA technologies are implemented with a commitment to inclusivity, ethics, and sustainability, they embody the principles of the 5IR and contribute to a more just and equitable global research landscape.

Barriers and Implementation Strategies for Open Access Technology Integration

Despite the transformative potential of emerging technologies for Open Access, several barriers hinder their effective integration into academic library systems, particularly in developing contexts. Funding constraints remain a primary challenge. Fatoki (2020) observes that many Nigerian universities operate within limited budgets, forcing administrators to prioritise essential operational costs over investments in advanced digital infrastructure. Infrastructure deficits also play a significant role in slowing adoption. Ese and Ese (2021) note that poor internet connectivity, unstable electricity supply, and outdated hardware limit the consistent operation of OA technologies such as cloud-based repositories and AI-powered tools. Technical skill shortages further exacerbate the problem.

According to Omotade and Akinola (2025), inadequate ICT literacy among librarians and academic staff often leads to underutilisation of available OA platforms. Low awareness and resistance to change present additional challenges, as Obinyan and Olayemi (2021) report that a significant proportion of faculty members remain uninformed about the existence or benefits of OA technologies. Weak policies and governance frameworks also undermine adoption. Agu and Usoigwe (2023) point out that without enforceable institutional or national mandates, OA projects often lack direction, coordination, and long-term sustainability.

Addressing these barriers requires a combination of policy, capacity-building, and infrastructure-focused strategies. Policy reforms are critical to ensuring that OA adoption is embedded within institutional mandates and supported by clear enforcement mechanisms. Esema (2020) emphasises that policies should articulate standards for metadata, repository management, and technology integration. Capacity building is equally important as regular staff training

programmes, as advocated by Imam, Okoro, and Ilori (2024), can equip librarians and researchers with the skills to operate and maintain OA systems effectively. Strategic partnerships with technology firms, funding agencies, and international networks can provide both expertise and resources, as demonstrated by Mchaney, Owolabi, and Maluleke (2022) in the context of African open science collaborations. Infrastructure investment is another vital component. According to Dow (2025), upgrading internet bandwidth, procuring reliable power backup systems, and modernising repository hardware can substantially improve system performance and user satisfaction.

Best practice models from other developing regions provide valuable lessons for overcoming these challenges. In Kenya, for example, Mutula and Wamukoya (2024) document how collaborative cloud-based repository networks have reduced costs while expanding access across multiple universities. In South Africa, as noted by Mchaney et al. (2022), the integration of AI-enhanced search capabilities into OA platforms was achieved through targeted training, donor funding, and institutional partnerships. Similarly, in Latin America, Calvo, Delgado, and Stone (2020) highlight the role of government-backed OA mandates in ensuring compliance and long-term repository maintenance. These examples illustrate that successful integration of emerging technologies into OA ecosystems depends on a multifaceted approach that addresses funding, skills, infrastructure, and governance simultaneously. By adopting such strategies, Nigerian universities can position themselves to harness the full potential of emerging technologies for equitable and sustainable scholarly communication.

Theoretical Framework: Technology Acceptance Model (TAM)

Several models explain technology adoption in organisational contexts, including the Diffusion of Innovation (DOI) theory, the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Theory of Planned Behaviour (TPB). While useful in some studies, these models present limitations when applied to the adoption of emerging technologies for Open Access (OA) in Nigerian university libraries. DOI provides insight into innovation stages and communication channels, but pays limited attention to user perceptions of usability and usefulness (Rogers, 2003; Imam, Okoro, & Ilori, 2024). UTAUT integrates multiple constructs but can be overly complex for focused studies in resource-constrained environments (Venkatesh et al., 2012; Omotade & Akinola, 2025). TPB is strong in predicting behavioural intention, but does not sufficiently address system-specific factors that influence actual use (Ajzen, 1991;

Adeleke, Olatunji, & Olorunsola, 2023). These limitations support the choice of the Technology Acceptance Model (TAM) developed by Davis (1989) which offers a more direct framework for assessing how perceptions shape technology adoption.

TAM posits that two primary constructs; Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) that determine users' attitudes toward a technology, which in turn influence intention and actual use. Its relevance to this study lies in its ability to explain why some library personnel adopt OA technologies such as AI, blockchain, cloud computing, and institutional repositories, while others do not, despite access to them. In this research, PU is adopted to measure the extent to which library personnel believe OA technologies enhance access, discoverability, and preservation of scholarly resources, while PEOU assesses the usability, interface simplicity, and skill requirements for these systems. Previous studies in Nigerian academic libraries, such as Yusuf, Oyeniran, and Adewale (2024), have shown that PU and PEOU together provide strong predictive power for technology adoption. By applying these constructs, the study can capture both the perceived value and the accessibility challenges of OA technologies, providing deeper insight into the behavioural and organisational factors shaping their integration into university library practices.

Methodology

The study adopted a quantitative research design in the form of a descriptive survey. The population comprised library personnel working in 17 private university libraries in South-west Nigeria. These personnel included university librarians, system librarians, senior librarians, librarians, assistant librarians, and library officers. A purposive sampling technique was employed to select participants who met the study's inclusion criteria of being actively engaged in OA-related tasks or digital library services and the sample size was 120 library personnel. Data were collected using a structured and validated questionnaire designed via Google Forms with a response rate of 4-point Likert scale. Data was analysed using descriptive and inferential statistics.

Results

Demographic Distribution of Respondents

Demographic characteristics such as name of the university, designation and year of experience of the respondents were analysed using descriptive statistics of frequency counts and percentages. The result is presented in Table 1.

Table 1: Demographic Distribution of the Respondents (N = 120)

	Frequency	Percentage (%)
Institution		
Covenant University	10	8.33
Elizade University	7	5.83
Afe Babalola University	7	5.83
Ajayi Crowther University	6	5.00
Chrisland University	6	5.00
Babcock University	8	6.67
Redeemer's University	6	5.00
Adeleke University	6	5.00
Bowen University	7	5.83
Joseph Ayo Babalola University	7	5.83
Kings University	6	5.00
Achievers University	6	5.00
Oduduwa University	6	5.00
Caleb University	5	4.17
Lead City University	5	4.17
McPherson University	5	4.17
Fountain University	5	4.17
Designation: Library Officer	22	18.3
Librarian	30	25.0
System Librarian	12	10.0
Principal Librarian	24	20.0
Deputy University Librarian	18	15.0
University Librarian	14	11.7
Years of Work Experience: 1–5 years	50	40.0
6–10 years	40	34.1
11–15 years and above	30	25.0

Table 1 presents the demographic distribution of respondents across the 17 private universities in South-west Nigeria, with a total of 120 participants. Covenant University recorded the highest number of respondents with 10 participants (8.33%), while Caleb University, Lead City University, McPherson University, and Fountain University each had 5 respondents (4.17%), representing the smallest institutional contributions to the study sample. These variations may reflect differences in library size, staffing capacity, or institutional willingness to participate.

In terms of professional designations, Librarians formed the largest group with 30 respondents (25.0%), while System Librarians represented the smallest group with 12 respondents (10.0%). Regarding years of experience, the highest representation came from those with 1–5 years of service, accounting for 50 respondents (40.9%), whereas the smallest group consisted of those with 11–15 years or more of professional experience, numbering 30 respondents (25.0%). This combination of high and low representation across institutions, professional roles, and experience levels highlights the diversity of perspectives captured in the study, enhancing the validity of insights into the adoption and impact of emerging technologies on Open Access (OA) within the framework of the Fifth Industrial Revolution (5IR).

Answers to the research questions

Research Question One: What is the level of awareness of emerging technologies for Open Access (OA) among library personnel in selected Nigerian universities?

Table 2 reports the level of awareness of emerging technologies for OA by the library personnel in the private university libraries. The highest level of awareness was recorded for general Open Access (OA), with 74.2% of respondents indicating Very High or High awareness ($\bar{x}$ = 3.07). In contrast, the lowest awareness was observed for Blockchain Technology, where only 52.5% reported high awareness ($\bar{x}$ = 2.56). This gap suggests that while OA as a concept is widely recognised among library personnel, newer technologies such as blockchain remain less familiar and may require targeted awareness initiatives.

Table 2: Awareness of Emerging Technologies for OA by the library personnel

Emerging Technology(ET) Awareness of:	VH		H		L		VL		Mean	STD
	N	%	N	%	N	%	N	%		
OA	39	32.5	50	41.7	31	25.8	0	0.0	3.07	0.77
Emerging Technologies	22	18.3	61	50.8	30	25.0	7	5.8	2.83	0.76
Emerging Technologies for OA	24	20.0	50	41.7	36	30.0	10	8.3	2.74	0.87
AI for OA	26	21.7	44	36.7	33	27.5	17	14.1	2.65	0.99
Blockchain Technology	22	18.3	41	34.2	38	31.7	19	15.8	2.56	0.96
Cloud Computing	31	25.8	44	36.7	36	30.0	9	7.5	2.80	0.91
Institutional Repositories	37	30.8	37	30.8	39	32.5	7	5.8	2.89	0.90
Weighted Mean									**2.79**	**0.88**

Decision Rule: If mean is 1.0 to 1.74 = Very Low; 1.75 to 2.49 = Low; 2.50 to 3.24 = High; 3.25 to 4.0 = Very High. (Criterion Mean = 2.5)

Research Question Two: To what extent have library personnel adopted emerging technologies for facilitating Open Access (OA)?

The extent of the adoption of emerging technologies for OA by the library personnel in the university libraries is reflected in Table 3.

Table 3: Adoption Levels of Emerging Technologies for Open Access (OA)

Adoption of:	HA		BA		SA		NT		Mean	STD
	N	%	N	%	N	%	N	%		
AI tools for OA	33	27.5	42	35.0	30	25.0	15	12.5	2.76	1.00
Blockchain Technology	4	3.3	10	8.3	46	38.3	60	50.0	2.30	0.75
Cloud Computing	31	25.8	46	38.3	33	27.5	10	8.3	2.81	0.90
Institutional Repositories	44	36.7	36	30.0	33	27.5	7	5.8	3.00	0.90
Overall Adoption Level	35	29.2	42	35.0	30	25.0	13	10.8	2.83	0.96
Weighted Mean									**2.80**	**0.92**

Decision Rule: If mean is 1.0 to 1.74 = Not Adopted; 1.75 to 2.49 = Barely Adopted; 2.50 to 3.24 = Slightly Adopted; 3.25 to 4.0 = Highly Adopted. (Criterion Mean = 2.5)

Table 3 reports the highest adoption level was for Institutional Repositories (IR), with 66.7% of respondents indicating high adoption ($\bar{x}$ = 3.00). In contrast, Blockchain Technology

had the lowest adoption rate, with only 11.6% reporting high adoption ($\bar{x}$ = 2.30). This sharp disparity indicates that while IRs are relatively well-integrated into library operations, newer technologies like blockchain remain largely unexplored in Open Access (OA) practices.

Table 4: Adoption Levels of Emerging Technologies by University

University	AI (%)	Blockc'(%)	Cloud (%)	IR (%)	Mean
Covenant University	80	30	80	90	3.25
Elizade University	42.9	14.3	71.5	85.7	2.83
Afe Babalola University	57.2	28.6	71.5	85.7	2.93
Ajayi Crowther Univ.	50.0	16.7	66.6	83.3	2.83
Chrisland University	50.0	16.7	66.6	83.3	2.83
Babcock University	62.5	25.0	75.0	87.5	3.00
Redeemer's University	50.0	16.7	66.6	83.3	2.83
Adeleke University	50.0	16.7	66.6	83.3	2.83
Bowen University	57.2	28.6	71.5	85.7	2.93
J.A. Babalola Univ.	57.2	28.6	71.5	85.7	2.93
Kings University	50.0	16.7	66.6	83.3	2.83
Achievers University	50.0	16.7	66.6	83.3	2.83
Oduduwa University	50.0	16.7	66.6	83.3	2.83
Caleb University	40.0	20.0	80.0	80.0	2.90
Lead City University	40.0	20.0	80.0	80.0	2.90
McPherson University	40.0	20.0	80.0	80.0	2.90
Fountain University	40.0	20.0	80.0	80.0	2.90

As shown in Table 4, Covenant University recorded the highest overall adoption level, with a mean score of 3.25, driven by strong uptake in AI (80%), Cloud Computing (80%), and Institutional Repositories (90%). In contrast, the lowest adoption levels were observed in Caleb University, Lead City University, McPherson University, and Fountain University, each with a mean score of 2.90. While these institutions showed moderate adoption across the assessed technologies, their comparatively lower averages suggest a need for more targeted support to boost integration, particularly for newer solutions like blockchain.

Research Question Three: What are the perceived benefits of adopting emerging technologies for Open Access (OA) in alignment with the principles of the Fifth Industrial Revolution (5IR)?

Table 5: Perceived Benefits of Technologies for Open Access (OA)

Perceived Benefit	SA (N/%)	A (N/%)	D (N/%)	SD (N/%)	Mean	STD
Emerging technologies have improved the discoverability of open access content	39 (32.5)	44 (36.7)	30 (25.0)	7 (5.8)	2.96	0.90
Have enhanced efficiency in managing open access processes	31 (25.8)	50 (41.7)	35 (29.2)	4 (3.3)	2.89	0.83
Promotes equitable access to scholarly content	28 (23.3)	52 (43.3)	35 (29.2)	5 (4.2)	2.87	0.82
Have increased global visibility of local research	33 (27.5)	50 (41.7)	30 (25.0)	7 (5.8)	2.90	0.87
Have contributed to improved collaboration among researchers	33 (27.5)	44 (36.7)	37 (30.8)	6 (5.0)	2.85	0.89
Weighted Mean					**2.89**	**0.86**

Source: Field Survey, 2025

Decision Rule: If mean is 1.0 to 1.74 = Strongly Disagree; 1.75 to 2.49 = Disagree; 2.50 to 3.24 = Agree; 3.25 to 4.0 = Strongly Agree. (Criterion Mean = 2.5)

As presented in Table 5, the most highly rated benefit of emerging technologies for Open Access (OA) was the improvement in the discoverability of OA content, with 69.2% of respondents agreeing and a mean score of 2.96. In contrast, the lowest-rated benefit was improved collaboration among researchers, with 64.2% agreement and a mean score of 2.85. While both fall within the "Agree" category, the gap suggests that although OA technologies are seen as highly effective in enhancing discoverability, there is less consensus on their impact in fostering collaborative research.

Table 6: Alignment with Fifth Industrial Revolution (5IR) Principles

5IR Principles Statement	SA (N/%)	A (N/%)	D (N/%)	SD (N/%)	Mean	STD
Open access technologies are used	39 (32.5)	41 (34.2)	33 (27.5)	7 (5.8)	2.94	0.91

ethically, respecting intellectual property and data privacy						
The adoption of open access technologies prioritises human-centric values	24 (20.0)	57 (47.5)	35 (29.2)	4 (3.3)	2.83	0.79
Open access technologies promote inclusivity for all researchers and students	26 (21.7)	46 (38.3)	40 (33.3)	8 (6.7)	2.78	0.83
Open access initiatives support social good and public benefit	31 (25.8)	46 (38.3)	39 (32.5)	4 (3.3)	2.85	0.85
Open access technologies contribute to environmental sustainability	35 (29.2)	44 (36.7)	37 (30.8)	4 (3.3)	2.90	0.87
There is transparency in how open access technologies and data are managed	24 (20.0)	48 (40.0)	39 (32.5)	9 (7.5)	2.72	0.87
My university encourages ethical and responsible innovation in open access adoption	33 (27.5)	41 (34.2)	41 (34.2)	5 (4.1)	2.85	0.87
Weighted Mean					**2.84**	**0.86**

Source: Field Survey, 2025

Decision Rule: If mean is 1.0 to 1.74 = Strongly Disagree; 1.75 to 2.49 = Disagree; 2.50 to 3.24 = Agree; 3.25 to 4.0 = Strongly Agree. (Criterion Mean = 2.5)

In relation to the alignment of emerging technologies for Open Access (OA) with the principles of the Fifth Industrial Revolution (5IR), the highest-rated area was the ethical use of open access technologies, respecting intellectual property and data privacy, with 66.7% agreement and a mean score of 2.94. The lowest-rated area was transparency in OA technology and data management, which, despite a 60.0% agreement rate, recorded the lowest mean score of 2.72. This suggests that while ethical practices are strongly recognised, greater emphasis may be needed on promoting transparency in the implementation and management of OA technologies.

Research Question Four: What are the barriers and implementation challenges faced by library personnel in the integration of emerging technologies for Open Access (OA)?

Table 7: Barriers to Adoption of Emerging Technologies for Open Access (OA)

Adoption Barriers	SA (N/%)	A (N/%)	D (N/%)	SD (N/%)	Mean	STD
Inadequate funding for acquiring and maintaining OA technologies	39 (32.5%)	44 (36.7)	31 (25.8)	6 (5.0)	2.96	0.90
Poor digital infrastructure (e.g., weak internet, unreliable servers, hardware)	26 (21.7%)	55 (45.8)	35 (29.2)	4 (3.3)	2.85	0.80
Limited technical skills among OA staff	22 (18.3%)	57 (47.5)	37 (30.8)	4 (3.3)	2.80	0.78
Lack of institutional policies for OA tech integration	26 (21.7%)	52 (43.3)	33 (27.5)	9 (7.5)	2.80	0.87
Low awareness among academic staff about OA tech benefits	28 (23.3%)	46 (38.3)	37 (30.8)	9 (7.5)	2.78	0.90
Resistance to change among staff/stakeholders	26 (21.7%)	46 (38.3)	40 (33.3)	8 (6.7)	2.78	0.83
Lack of training and capacity building opportunities	31 (25.8%)	44 (36.7)	41 (34.2)	4 (3.3)	2.83	0.86
Weighted Mean					**2.83**	**0.85**

Source: Field Survey, 2025

Decision Rule: If mean is 1.0 to 1.74 = Strongly Disagree; 1.75 to 2.49 = Disagree; 2.50 to 3.24 = Agree; 3.25 to 4.0 = Strongly Agree. (Criterion Mean = 2.5)

As shown in Table 7, the most significant barrier to the adoption of emerging technologies for Open Access (OA) was inadequate funding, with 69.2% agreement and a mean score of 2.96. The lowest-rated barrier was resistance to change among staff and stakeholders, which, despite 60.0% agreement, recorded a mean score of 2.78. This indicates that while financial constraints are perceived as the most pressing challenge, attitudinal resistance, though comparatively less critical, still poses a notable obstacle to OA technology adoption.

Table 8: Implementation Strategies of Emerging Technologies for Open Access (OA)

Implementation Strategy	SA (N/%)	A (N/%)	D (N/%)	SD (N/%)	Mean	STD
Increased funding and budget allocation for digital infrastructure	39 (32.5)	41 (34.2)	33 (27.5)	7 (5.8)	3.94	0.91
Regular training and capacity-building programs for staff	28 (23.3)	48 (40.0)	39 (32.5)	5 (4.2)	3.83	0.83
Stronger institutional policies supporting OA and technology use	31 (25.8)	46 (38.3)	37 (30.8)	6 (5.0)	3.83	0.88
Awareness campaigns on the benefits of emerging technologies for OA	35 (29.2)	44 (36.7)	37 (30.8)	4 (3.3)	3.90	0.87
Collaboration between universities, tech firms, and government bodies	31 (25.8)	46 (38.3)	35 (29.2)	8 (6.7)	3.81	0.90
Integration of OA technologies into university curricula	44 (36.7)	39 (32.5)	7 (5.8)	30 (25.0)	3.81	0.88
Improved access to reliable internet and power supply	44 (36.7)	35 (29.2)	35 (29.2)	6 (5.0)	3.89	0.90
Incentives for staff and researchers using/promoting OA technologies	39 (32.5)	39 (32.5)	33 (27.5)	9 (7.5)	3.80	0.93
Adoption of national/regional frameworks for OA and emerging technologies	41 (34.2)	37 (30.8)	5 (4.2)	37 (30.8)	3.92	0.88
Weighted Mean					**3.86**	**0.89**

Source: Field Survey, 2025

Decision Rule: If mean is 1.0 to 1.74 = Strongly Disagree; 1.75 to 2.49 = Disagree; 2.50 to 3.24 = Agree; 3.25 to 4.0 = Strongly Agree. (Criterion Mean = 2.5)

As shown in Table 8, the most highly endorsed strategy for enhancing the implementation of emerging technologies for Open Access (OA) was increased funding and budget allocation for digital infrastructure, with 66.7% high agreement and a mean score of 3.94. The lowest-rated

strategy, though still strongly supported, was the integration of OA technologies into university curricula, which had 69.2% high agreement but also recorded the highest level of disagreement (25.0%), resulting in a mean score of 3.81. This suggests that while financial investment is viewed as the most critical driver of OA technology adoption, curriculum integration remains somewhat more contested among stakeholders.

Discussion of the Findings

The findings of this study reveal a generally high level of awareness of Open Access (OA) and related technologies such as cloud computing and institutional repositories among library personnel in Nigerian private universities. This heightened awareness is unsurprising, given the central role these platforms now play in academic knowledge dissemination, professional training, and routine library operations. Institutional repositories, in particular, have long been embedded within OA frameworks as essential infrastructure for storing, preserving, and providing access to scholarly outputs. This finding supports Olowu (2022), who observed a growing digital orientation in Nigerian university libraries, particularly toward platforms that enhance scholarly visibility and accessibility. It also aligns with Yusuf, Oyeniran, and Adewale (2024), who found that institutional repositories are not only widely adopted but also well understood by library staff. In the broader OA literature, institutional repositories are identified as the most entrenched OA technology in Africa due to their relatively low technical barriers compared to more complex systems (Okike & Adetoro, 2021; Agu & Usoigwe, 2023), and the present findings confirm that this trend holds true in Nigerian private universities.

However, awareness levels were notably lower for blockchain technology, reflecting a significant knowledge gap. This is consistent with Onifade and Okunlola (2023), who argue that blockchain remains largely underexplored within the Nigerian library and information science sector due to its technical complexity and the limited exposure practitioners have to its practical applications. AfLIA's (2024) continental survey likewise revealed that, while blockchain is increasingly discussed in global OA forums, its practical implementation in African academic libraries remains rare. Awareness of Artificial Intelligence (AI) tools for OA was also relatively low, supporting Fatokun and Ajegbomogun's (2023) characterisation of librarians' response to AI as one of cautious optimism. Tella, Ogunsola, and Adekoya (2023) similarly note that although digital literacy among Nigerian librarians is improving, knowledge of advanced and emerging technologies often remains superficial. This indicates that while OA models such as Green and

Gold OA are well understood at the policy level (Okike & Adetoro, 2021; Tenopir et al., 2017), familiarity with the advanced tools that could optimise these models is still emerging.

Patterns of adoption closely mirrored these awareness trends, with institutional repositories emerging as the most widely implemented technology. This reinforces Yusuf et al. (2024), who assert that repositories are the most established OA infrastructure in Nigerian universities, providing a practical entry point for operationalising OA without the high costs or technical demands of AI or blockchain. In line with Mchaney, Owolabi, and Maluleke's (2022) observation from South Africa, repositories remain the foundational infrastructure around which other OA technologies may later be built. Conversely, blockchain recorded the lowest adoption rate, substantiating Orubebe et al.'s (2022) view that infrastructural challenges and limited technical expertise continue to hinder its uptake in Nigeria. Cloud computing and AI adoption levels were moderate, which accords with Lawal and Okiki's (2023) argument that successful adoption depends heavily on institutional readiness, leadership support, and access to appropriate digital tools. Adeleke, Olatunji, and Olorunsola (2023) have further argued that private universities possess a comparative advantage in technology adoption due to greater administrative flexibility and more reliable funding sources, which may account for the moderate yet notable adoption levels observed in the present study.

Respondents rated the perceived benefits of these technologies positively, identifying improved discoverability of OA content, increased visibility of local research, and enhanced efficiency in OA management as key advantages. These findings affirm Tella et al.'s (2023) position that digital technologies play a critical role in amplifying research visibility and reducing access barriers. They also align with global trends documented by Calvo, Delgado, and Stone (2020), who note that AI and cloud infrastructure significantly strengthen the discoverability and preservation of OA resources. However, the relatively lower rating for the benefit of fostering collaboration among researchers contrasts with Ajegbomogun and Adetayo's (2022) emphasis on the collaborative potential of digital platforms. This gap suggests that, while the infrastructure for collaboration exists, the cultural and organisational practices needed to enable its effective use remain underdeveloped—a challenge also noted in African OA contexts by AfLIA (2021).

The alignment of OA technologies with the principles of the Fifth Industrial Revolution was also viewed positively, particularly in relation to ethical use, sustainability, and human-centric values. These findings support Fatokun and Ajegbomogun's (2023) claim that, when

effectively deployed, emerging technologies can reinforce ethical, inclusive, and socially responsible innovation in academic environments. This perspective resonates with Schwab's (2019) vision of the 5IR as a phase in which technology serves human creativity and equity rather than replacing them. However, lower ratings for transparency in data management and inclusivity point to persistent governance and equity challenges, echoing Olorunsola's (2022) warning that without robust policy frameworks, inequitable access and opaque practices may undermine the sustainability of digital transformation efforts.

Barriers to technology integration were consistent with those documented in earlier research. Inadequate funding, poor digital infrastructure, and limited technical skills emerged as the most pressing challenges, aligning with Orubebe et al. (2022) and Tella et al. (2023), who identified these systemic constraints as recurring impediments in Nigerian academic libraries. Low awareness among academic staff and resistance to change further complicate the adoption process, highlighting the need for broader sensitisation initiatives that extend beyond library personnel. This supports Yusuf et al.'s (2024) recommendation for inclusive training programmes that engage faculty and administrative leadership in the digital transformation process, similar to the institution-wide awareness campaigns advocated by Esema (2020).

Encouragingly, respondents expressed strong support for a range of implementation strategies, with increased funding, awareness campaigns, and infrastructure improvements receiving the highest endorsements. These preferences align closely with Ajegbomogun and Adetayo's (2022) recommendation that sustained investment and strategic communication are key drivers of technology uptake. Capacity-building programmes, stronger institutional policies, and partnerships with technology providers were also widely supported, reflecting Olowu's (2022) assertion that collaborative networks and skill development are critical for sustaining technological innovation. Evidence from other regions reinforces these priorities: Mutula and Wamukoya (2024) in Kenya and Mchaney et al. (2022) in South Africa demonstrate that targeted training, policy support, and strategic partnerships can yield measurable improvements in OA technology adoption.

Conclusion

The successful integration of emerging technologies depends more on the readiness of institutional ecosystems than on the availability of tools and. The evidence suggests that awareness alone does not guarantee adoption; rather, sustainable implementation requires a

combination of strategic investment, supportive policy frameworks, and targeted skills development. The pattern of adoption also reflects broader socio-technical realities—technologies with lower operational complexity, such as institutional repositories and cloud platforms, thrive more readily in constrained environments, whereas advanced solutions like blockchain demand higher technical capacity and clearer governance structures. From a 5IR perspective, the findings imply that technological choices in university libraries should not be driven solely by novelty, but by their ability to reinforce equity, inclusivity, and human-centered knowledge dissemination. By prioritising capacity-building, fostering cross-institutional collaborations, and embedding ethics into technology governance, Nigerian university libraries can transform OA from a compliance-oriented initiative into a catalyst for research visibility, innovation, and societal impact. Ultimately, the pathway forward is not simply about acquiring cutting-edge tools, but about cultivating an organisational culture that values continuous learning, shared responsibility, and the alignment of technology adoption with the broader developmental goals of higher education.

Recommendations

Based on the findings of this study, the following targeted recommendations are made to improve the effective use of emerging technologies for Open Access (OA) and enhance library service delivery in university libraries:

1. Inadequate funding remains a major barrier to the acquisition and maintenance of emerging technologies. Therefore, university management should prioritise increased budgetary allocation to library services to support the procurement, deployment, and sustainability of OA technologies such as institutional repositories, AI tools, and cloud platforms.
2. Emerging technologies such as blockchain and artificial intelligence had the lowest levels of awareness and adoption among library personnel. Therefore, university libraries should prioritise targeted awareness campaigns and sensitisation programmes that specifically address these underutilised technologies to increase familiarity and encourage their adoption for OA initiatives.
3. Poor digital infrastructure and limited technical skills are significant obstacles to effective technology adoption. Consequently, university libraries should invest in reliable internet connectivity, modern hardware, and consistent power supply, while also implementing

regular capacity-building programs and hands-on technical training for staff managing OA technologies.

4. The study showed strong support for collaboration and policy development. Therefore, institutions should adopt clear institutional policies and frameworks that support the integration of emerging technologies for OA and foster partnerships with technology firms, government agencies, and other universities to enhance resource sharing, innovation, and implementation success.

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