

Harnessing Emerging Technologies in Polytechnic Libraries in North-Central Nigeria for Sustainable Development

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Abstract: Polytechnic libraries in North-Central Nigeria occupy a strategic position in the production of the technical and vocational manpower on which the region's development agenda depends, yet their capacity to harness emerging technologies such as artificial intelligence, cloud computing, the Internet of Things, radio-frequency identification, and chatbot-mediated reference services remains constrained. This paper interrogates how emerging technologies can be deployed by polytechnic libraries to advance the Sustainable Development Goals, particularly those relating to quality education, industry and innovation, and partnerships. Anchored on the Technology-Organisation-Environment framework and Rogers' Diffusion of Innovations theory, the paper adopts a desk-review methodology, synthesising recent empirical and conceptual literature on ICT and emerging technology adoption in Nigerian academic and polytechnic libraries. The discussion establishes that while emerging technologies hold considerable promise for expanding access, improving research support, and repositioning polytechnic libraries as knowledge hubs for sustainable development, adoption is impeded by epileptic power supply, weak internet infrastructure, inadequate funding, limited digital competence among library personnel, and institutional resistance to change. The paper argues that harnessing these technologies for sustainable development requires deliberate policy attention, sustained investment in infrastructure and staff capacity, and stronger collaboration between polytechnic management, government agencies, and development partners. The paper concludes with practical recommendations for library managers, polytechnic administrators, and policymakers in the sub-region.

Keywords: *Emerging Technologies, Polytechnic Libraries, Sustainable Development, North-Central Nigeria, Technology Adoption.*

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I. INTRODUCTION

The last two decades have witnessed a rapid transformation in the way information is created, organised, stored, and disseminated across the globe, driven largely by advances in digital and emerging technologies. Academic libraries, as custodians of knowledge and enablers of teaching, learning, and research, have not been left out of this transformation. Emerging technologies such as artificial intelligence (AI), cloud computing, the Internet of Things (IoT), robotics, blockchain, radio-frequency identification

(RFID), and chatbot-driven virtual reference services are increasingly reshaping library operations, service delivery, and user engagement worldwide (Agboke & Oladokun, 2025).

In Nigeria, polytechnic libraries occupy a peculiar position within the higher education landscape. Unlike university libraries, which have received relatively more scholarly and policy attention, polytechnic libraries serve a technical and vocational student population whose training is expected to translate directly into the industrial,

entrepreneurial, and technical manpower needed for national development. Polytechnic libraries in North-Central Nigeria, spanning states such as Kogi, Kwara, Niger, Benue, Plateau, and the Federal Capital Territory, therefore carry a dual responsibility: supporting the immediate academic needs of students and lecturers, and contributing to the broader sustainable development agenda of the sub-region through the production of technologically literate graduates.

Sustainable development, as conceived by the United Nations, rests on the integration of economic growth, social inclusion, and environmental protection, and is operationalised through the seventeen Sustainable Development Goals (SDGs), with Goal 4 (quality education), Goal 9 (industry, innovation, and infrastructure), and Goal 17 (partnerships for the goals) being particularly relevant to library and information services. Emerging technologies, when appropriately harnessed, offer polytechnic libraries a pathway to strengthen access to information resources, support research and innovation, and forge partnerships that advance these goals. However, empirical evidence from Nigerian academic libraries consistently points to a gap between the promise of emerging technologies and their actual utilisation, a gap shaped by infrastructural, financial, and human capacity constraints (Alabi et al., 2024).

It is against this backdrop that this paper examines how polytechnic libraries in North-Central Nigeria can harness emerging technologies for sustainable development. The paper reviews relevant literature, situates the discussion within the Technology-Organisation-Environment (TOE) framework and Rogers' Diffusion of Innovations theory, identifies the technologies most relevant to the polytechnic library context, examines the challenges to their adoption, and proposes strategies for their effective deployment.

II. STATEMENT OF THE PROBLEM

Despite the growing body of literature on emerging technologies in academic libraries, polytechnic libraries in North-Central Nigeria remain under-researched and, in practice, under-resourced. Many polytechnic libraries in the sub-region still operate largely manual or semi-automated systems, with limited or no access to cloud-based platforms, AI-driven discovery tools, or automated circulation and security systems such as RFID. Where such technologies exist, their use is often confined to a narrow range of functions and is undermined by unreliable electricity supply, poor internet bandwidth, and a shortage of ICT-competent personnel (Adeyemi et al., 2025). This state of affairs constrains the ability of polytechnic libraries to fulfil their mandate of supporting technical and vocational education, thereby limiting their contribution to the sustainable development goals that depend on a technologically empowered and information-literate workforce. The problem this paper addresses, therefore, is the need to understand both the opportunities that emerging technologies present for polytechnic libraries in North-Central Nigeria and the constraints that must be overcome if these technologies are to be harnessed meaningfully for sustainable development.

➤ Objectives of the Study

The paper is guided by the following objectives:

- Examine the emerging technologies with relevance to library service delivery in polytechnic libraries in North-Central Nigeria;
- Explore the nexus between emerging technologies and the attainment of the Sustainable Development Goals in the polytechnic education sub-sector;
- Identify the challenges militating against the adoption of emerging technologies in polytechnic libraries in the sub-region; and
- Propose strategies for harnessing emerging technologies for sustainable development in polytechnic libraries in North-Central Nigeria.

III. CONCEPTUAL CLARIFICATION

➤ Emerging Technologies

Emerging technologies refer to novel or rapidly developing technological tools and systems that are still evolving in application but hold transformative potential for existing practices. In the library context, these include artificial intelligence and machine learning, cloud computing, the Internet of Things, robotics, blockchain, RFID, big data analytics, virtual and augmented reality, and chatbot-based virtual reference systems. These technologies are described as "emerging" not because they are entirely new to global discourse, but because their integration into library operations in developing contexts such as Nigeria is still at a formative stage (Agboke & Oladokun, 2025).

➤ Polytechnic Libraries

Polytechnic libraries are academic libraries domiciled in polytechnics and monotechnics, established primarily to support technical, vocational, and applied education. They differ from university libraries in the emphasis placed on practical, industry-oriented information resources such as technical manuals, engineering standards, and applied science literature. In North-Central Nigeria, polytechnic libraries serve institutions such as Kogi State Polytechnic, Kwara State Polytechnic, Niger State Polytechnic, and the Federal Polytechnics in the sub-region, among others, and are central to the training of middle-level technical manpower for the Nigerian economy.

➤ Sustainable Development

Sustainable development is generally understood as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The United Nations' 2030 Agenda operationalises this concept through seventeen interlinked goals covering poverty, education, industry, innovation, and partnerships, among others. For polytechnic libraries, the most directly relevant goals are Goal 4 (ensuring inclusive and equitable quality education), Goal 9 (building resilient infrastructure and fostering innovation), and Goal 17 (strengthening partnerships for the goals), all of which are strengthened by an information infrastructure capable of supporting research, innovation, and lifelong learning.

➤ *Theoretical Framework*

This paper draws on two complementary theories to explain the adoption of emerging technologies in polytechnic libraries: the Technology-Organisation-Environment (TOE) framework and Rogers' Diffusion of Innovations (DOI) theory.

The TOE framework, developed by Tornatzky and Fleischer (1990), posits that the adoption of technological innovation by an organisation is shaped by three contexts: the technological context (the characteristics and availability of relevant technologies), the organisational context (institutional resources, structure, and readiness), and the environmental context (external factors such as government policy, competitive pressure, and infrastructural conditions). Applied to polytechnic libraries, the TOE framework helps explain why libraries with similar technological options may differ markedly in their level of technology adoption, depending on institutional funding priorities, management support, and the broader infrastructural environment in which they operate.

Rogers' (2003) Diffusion of Innovations theory complements the TOE framework by explaining how and why innovations spread within a social system over time, through the interplay of the innovation's relative advantage, compatibility, complexity, trialability, and observability. Within the polytechnic library context, DOI theory illuminates the process by which individual librarians and library management move from initial awareness of an emerging technology to its eventual adoption or rejection, and highlights the role of early adopters, opinion leaders, and communication channels in accelerating or slowing this process. Taken together, the two theories provide a robust lens for understanding both the institutional and behavioural dimensions of emerging technology adoption in polytechnic libraries.

IV. EMERGING TECHNOLOGIES RELEVANT TO POLYTECHNIC LIBRARIES

Several categories of emerging technology have direct relevance to polytechnic library operations and service delivery in North-Central Nigeria.

➤ *Artificial Intelligence and Chatbots*

AI-powered discovery systems and chatbots can support round-the-clock virtual reference services, automate routine enquiries, and personalise information delivery to students and lecturers. Studies on the application of emerging technologies in Nigerian academic libraries note that AI and robotics are already reshaping circulation, security, and reference services in a growing number of institutions, though adoption remains uneven (Agboke & Oladokun, 2025).

➤ *Cloud Computing*

Cloud computing offers polytechnic libraries a cost-effective route to scalable storage, remote access to digital collections, and reduced dependence on expensive in-house infrastructure. A recent study of university libraries in North-Central Nigeria found that although cloud adoption offers

clear benefits for service delivery, its uptake is hindered by poor institutional subscription, weak internet infrastructure, and staff resistance to change, and recommended continuous training and improved funding as the most highly rated strategies for enhancing adoption (Alabi et al., 2024).

➤ *RFID and Automated Systems*

Radio-frequency identification technology enables automated check-in and check-out, real-time inventory control, and improved security of library collections, reducing the labour intensity of circulation and stock-taking functions that still consume significant staff time in many polytechnic libraries.

➤ *Big Data, Institutional Repositories, and Research Support Tools*

Emerging technologies also support the research mission of polytechnic libraries through institutional repositories, altmetrics, and research-impact tracking tools that improve the visibility of staff and student research output. A review of emerging technology application for research support in Nigerian academic libraries identifies growing but uneven use of such tools, and highlights the continuing need for capacity building among library staff to fully exploit their potential (Adeyeye & Oladokun, 2023).

➤ *Virtual and Augmented Reality*

For technical and vocational programmes in particular, virtual and augmented reality tools offer polytechnic libraries an opportunity to support simulation-based learning in engineering, applied science, and technology programmes, complementing the practical orientation of polytechnic education.

➤ *Emerging Technologies and the Sustainable Development Nexus*

The relationship between emerging technologies and sustainable development in the polytechnic library context can be understood through three interlocking pathways. First, in relation to Goal 4 (quality education), emerging technologies expand access to learning resources beyond the physical library, support flexible and lifelong learning, and narrow the resource gap between polytechnic libraries and better-funded university libraries. Digital technology adoption in Nigerian academic libraries has been associated with improved access to repositories, mobile services, and digital collections, which are central to inclusive quality education (Agbetuyi & Olorunyomi, 2025).

Second, in relation to Goal 9 (industry, innovation, and infrastructure), polytechnic libraries that harness emerging technologies contribute directly to building the technological infrastructure and innovation culture that technical and vocational education is meant to produce. A library that models the effective use of cloud computing, RFID, and AI-based tools helps normalise these technologies for a student population that will later apply similar tools in industry.

Third, in relation to Goal 17 (partnerships for the goals), the adoption of emerging technologies often depends on, and in turn strengthens, collaboration between polytechnic

libraries, government agencies, development partners, and technology vendors. Cloud-based resource-sharing arrangements and consortia purchasing of digital resources exemplify the kind of partnership-driven adoption that can make emerging technologies more affordable and sustainable for individual polytechnic libraries operating under tight budgets.

➤ *Challenges to Harnessing Emerging Technologies in Polytechnic Libraries in North-Central Nigeria*

Evidence from recent studies on ICT and emerging technology adoption in Nigerian academic and polytechnic libraries points to a recurring set of constraints.

Epileptic power supply. Unreliable electricity remains one of the most frequently cited barriers to sustained use of cloud-based and other digital systems, as interruptions compromise data integrity and discourage continued investment in digital infrastructure (Alabi et al., 2024).

Weak internet connectivity and bandwidth. Low bandwidth restricts access to cloud services, digital repositories, and streaming-dependent tools, and widens the digital divide between polytechnic libraries in urban and semi-urban locations within the sub-region.

Inadequate funding. Polytechnic libraries typically compete for scarce institutional resources with other units, leaving little budgetary provision for the subscription, licensing, and maintenance costs associated with emerging technologies.

Limited digital competence among library personnel. Many polytechnic library staff have not received adequate training in emerging technologies, a gap that studies consistently identify as a major impediment to effective adoption and utilisation (Adeyeye & Oladokun, 2023).

Institutional and attitudinal resistance. Staff apprehension about job displacement, unfamiliarity with new systems, and weak management commitment to change contribute to slow uptake even where the requisite technology is available (Alabi et al., 2024).

Policy and infrastructural gaps at the institutional and national levels, including the absence of clear ICT policies for polytechnic libraries and inconsistent government support for technology infrastructure in tertiary institutions across the sub-region.

➤ *Strategies for Harnessing Emerging Technologies for Sustainable Development*

Drawing on the challenges identified and the TOE and DOI frameworks, the paper proposes the following strategies:

- Institutional investment in reliable power alternatives (solar and inverter systems) and improved internet bandwidth to create a stable technological environment for emerging technology adoption.
- Deliberate and continuous capacity-building programmes for library staff, covering AI tools, cloud platforms, RFID

systems, and data management, to close the digital competence gap.

- Increased and dedicated budgetary allocation for library technology, supported by advocacy from library management to polytechnic governing councils and the Tertiary Education Trust Fund (TETFund) and similar bodies.
- Consortia and resource-sharing arrangements among polytechnic libraries in North-Central Nigeria to reduce the cost of cloud subscriptions and digital resource licensing through collective bargaining.
- Change-management initiatives that address staff apprehension directly, building confidence and demonstrating the relative advantage of emerging technologies through pilot projects and peer-to-peer learning, consistent with the diffusion principles of trialability and observability.
- Stronger partnerships between polytechnic libraries, government agencies, technology vendors, and development partners to attract funding, technical support, and training opportunities aligned with Goal 17 of the SDGs.
- Development of institution-specific ICT and emerging technology policies that provide a clear roadmap, assign responsibility, and set measurable targets for technology adoption in polytechnic libraries.

V. CONCLUSION

Emerging technologies offer polytechnic libraries in North-Central Nigeria a real opportunity to reposition themselves as active contributors to the sustainable development agenda of the sub-region, particularly in relation to quality education, industry and innovation, and cross-sector partnerships. However, the realisation of this potential is far from automatic. The recurring evidence of infrastructural deficits, inadequate funding, limited staff competence, and institutional resistance across the reviewed literature indicates that technology alone cannot drive transformation; it must be accompanied by deliberate institutional and policy commitment. Anchored on the TOE framework and Rogers' Diffusion of Innovations theory, this paper has argued that harnessing emerging technologies for sustainable development in polytechnic libraries requires attention to the technological, organisational, and environmental conditions that shape adoption, as well as to the behavioural processes through which library staff and management come to accept and use new tools.

RECOMMENDATIONS

Based on the foregoing discussion, the paper recommends that:

- Polytechnic management and governing councils prioritise funding for library ICT infrastructure, including power and connectivity solutions, as a strategic investment in institutional and national development;
- Polytechnic libraries in North-Central Nigeria establish regional consortia to pool resources for cloud subscriptions, digital licensing, and staff training;

- Library schools and professional bodies such as the Nigerian Library Association review curricula and continuing professional development programmes to reflect the competencies required for emerging technology adoption; and
- Future empirical research be conducted across a broader sample of polytechnic libraries in North-Central Nigeria to generate context-specific data on the extent and impact of emerging technology adoption.

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