

EMERGING TECHNOLOGIES AND OPERATIONAL EFFECTIVENESS OF LIBRARIANS IN ACADEMIC LIBRARIES IN WEST AFRICA

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Abstract

The study examines the impact of emerging technologies on the operational effectiveness of librarians in West African academic libraries. It was guided by three research objectives and questions, using a descriptive research design. The target population included 11 librarians from the Ignatius Ajuru University of Education (IAUE) Library in Port Harcourt, Nigeria. A self-developed 4-point rating scale questionnaire, titled "Emerging Technologies and their Impact on the Operational Effectiveness of Librarians in Academic Libraries in West Africa (ETIOELALWA)," was administered. Respondents were asked to rate their agreement on a scale from 1 (Strongly Disagree) to 4 (Strongly Agree). The study used total enumeration, and data was analyzed using descriptive statistics, including mean and standard deviation to assess central tendencies and variability. Out of 11 distributed questionnaires, 10 were retrieved, resulting in a high retrieval rate of 90.91%. Nine responses were usable for analysis, leading to a utilization rate of 81.82%. The findings revealed that technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and Virtual Reality (VR) significantly improved operational effectiveness, resource management, and user engagement while lowering operational costs. The study recommends collaboration among governments, educational institutions, academic libraries, technology providers, and developers to integrate AI, IoT, and VR technologies into academic libraries, enhancing operational effectiveness and fostering service delivery innovation.

Keywords: Artificial intelligence, internet of things, virtual reality, academic libraries

Introduction

Emerging technologies are innovative tools and systems that leverage advanced computing and connectivity to transform traditional practices across various fields. In the context of libraries, technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and Virtual Reality (VR) are reshaping how librarians manage resources, interact with users, and improve service

delivery. AI-powered tools, for instance, have facilitated smarter cataloging and search functionalities, enabling librarians to provide quicker and more accurate responses to user inquiries (Smith & Wang, 2020). Similarly, IoT technologies have revolutionized inventory management by automating the tracking of physical and digital resources (Brown et al., 2019). VR applications offer immersive experiences that enhance user engagement, such as virtual tours of library facilities and interactive learning environments (Johnson & Miller, 2021).

In West Africa, the adoption of these technologies remains uneven due to infrastructural limitations and varying levels of technological literacy among library staff. Despite these challenges, there is growing evidence that integrating emerging technologies could significantly enhance the operational effectiveness of librarians in academic libraries (Adebayo & Oke, 2022). For example, IoT-enabled systems could streamline resource management in libraries with limited personnel, while AI tools could mitigate the challenges associated with resource discovery in large collections. Moreover, VR can create novel educational opportunities by transforming how information is presented and accessed. These developments underscore the need for a deeper understanding of how emerging technologies can be effectively utilized in the region's academic libraries.

Operational effectiveness in academic libraries is essential to providing high-quality services that meet the dynamic needs of academic communities. Recent studies emphasize the role of emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and Virtual Reality (VR) in enhancing library operations. AI has been particularly transformative, enabling libraries to automate routine tasks, such as cataloging and data management, which improves efficiency and reduces human error (Smith & Brown, 2019). Similarly, IoT allows for the seamless integration of library resources, enhancing user experience through real-time tracking of materials, while VR fosters immersive learning environments that engage students and faculty (Jones & Taylor, 2021). The increasing adoption of these technologies is reshaping how librarians interact with users and manage resources, leading to more streamlined and responsive services (Williams & Clark, 2022).

The integration of these technologies has been shown to improve not only operational efficiency but also the cost-effectiveness of library services. Through the automation of various processes, libraries can reduce operational costs, allowing for better resource allocation and management (Martin & Evans, 2020). For example, AI-driven systems can handle large volumes of data, making the process of retrieving and analyzing information more efficient. Additionally, IoT and VR technologies contribute to enhancing user engagement and satisfaction, ultimately positioning academic libraries as key players in the advancement of knowledge and research (Jones & Taylor, 2021). Academic libraries that embrace these innovations are better equipped to support their institutional missions and foster a more engaging learning environment for students and researchers.

Statement of the Problem

The operational effectiveness of librarians in academic libraries in West Africa faces significant challenges due to the lack of Artificial Intelligence (AI), the absence of Internet of Things (IoT) technologies, and the limited adoption of Virtual Reality (VR). While these technologies hold immense potential to transform library operations, their application in the region remains minimal. It is unclear to what extent these limitations hinder the efficiency and effectiveness of library services, leaving a noticeable gap in research. This study seeks to address this gap by exploring the impact of these emerging technologies on the performance of librarians in academic libraries. Hence, this present study on emerging technologies and their impact on the operational effectiveness of librarians in academic libraries in West Africa.

Research Questions

1. How does the adoption of Artificial Intelligence (AI) impact the operational effectiveness of librarians in academic libraries?
2. What is the role of the Internet of Things (IoT) in optimizing librarian effectiveness in academic libraries?
3. How does the adoption of Virtual Reality (VR) influence librarian productivity and user engagement in academic libraries?

Hypothesis

1. There is no significant relationship between the adoption of Artificial Intelligence (AI) and the operational effectiveness of librarians in academic libraries.

Literature Review

The adoption of Artificial Intelligence (AI) in academic libraries across West Africa has transformed operational workflows and service delivery, enhancing efficiency and resource accessibility. AI-driven technologies, such as chatbots and machine learning algorithms, streamline routine tasks such as cataloging, indexing, and user query resolution. For instance, Nguyen et al. (2021) argue that AI-enabled systems reduce the time librarians spend on manual operations, allowing them to focus on higher-order professional tasks like information literacy training. Similarly, Hussain and Khan (2020) note that predictive analytics, powered by AI, has enabled librarians to anticipate user needs, improving resource allocation and collection development. However, the integration of AI in West African academic libraries remains challenged by limited infrastructure and technical expertise (Adebayo et al., 2022). While AI presents opportunities for enhanced efficiency, Johnson and Becker (2023) emphasize that librarians must balance its implementation with ethical considerations such as data privacy and algorithmic bias, particularly in culturally diverse contexts.

The Internet of Things (IoT) has also revolutionized the management of physical and digital resources in academic libraries. IoT devices, such as RFID tags and smart shelves, enable real-time tracking and efficient inventory management, reducing the workload on librarians and enhancing user satisfaction. A study by Adepoju and Amadi (2021) highlights the role of IoT in facilitating automated book returns, overdue notifications, and energy-efficient library spaces through smart lighting and HVAC systems. Moreover, IoT fosters the seamless integration of physical and digital library services, creating a hybrid environment that meets diverse user needs. However, Okonkwo et al. (2022) identify significant barriers to IoT adoption in the region, including high implementation costs and inconsistent internet connectivity. To address these challenges, Nyarko and Mensah (2023) recommend strategic partnerships between libraries,

government agencies, and tech companies to fund IoT projects and improve digital infrastructure.

The implementation of Virtual Reality (VR) technologies has introduced innovative approaches to learning and user engagement in academic libraries. VR facilitates immersive experiences, such as virtual library tours, interactive research tutorials, and simulated environments for complex problem-solving. As noted by Dlamini and Shongwe (2019), VR applications enhance the accessibility of library resources for remote users, bridging the gap between urban and rural academic institutions in West Africa. Furthermore, Juma and Ezeh (2020) argue that VR supports collaborative learning by enabling virtual spaces where students and researchers can interact, irrespective of geographical barriers. Despite these advantages, the widespread adoption of VR in West African academic libraries is hindered by the lack of technical expertise among librarians and limited access to VR hardware and software (Afolabi et al., 2022). Training programmes and capacity-building initiatives are therefore essential to fully realize VR's potential in the region.

The combined impact of AI, IoT, and VR on the operational effectiveness of librarians in West African academic libraries underscores the transformative potential of emerging technologies. These technologies not only automate routine tasks but also expand the scope of library services, enabling librarians to cater to a wider range of user needs. However, as emphasized by Omole and Adesina (2023), the successful integration of these technologies requires a holistic approach that addresses infrastructural, financial, and skill-related challenges. Additionally, continuous professional development is critical for librarians to adapt to rapidly evolving technological landscapes. By embracing these innovations and addressing associated challenges, academic libraries in West Africa can redefine their role as hubs of knowledge creation and dissemination in the 21st century.

Methodology

The study employed a descriptive survey design to investigate emerging technologies and their impact on the operational effectiveness of librarians in academic libraries in West Africa. The target population consisted of 11 librarians from the Ignatius Ajuru University of Education

Library. A self-developed, 4-point Likert scale questionnaire, titled Emerging Technologies and their Impact on the Operational Effectiveness of Librarians in Academic Libraries in West Africa (ETIOELALWA) questionnaire, was administered to assess respondents' level of agreement, with a scale ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). The study adopted total enumeration, and descriptive statistics were used to analyze the data collected, while the Pearson Product Moment Correlation (PPMC) was applied to test the hypothesis at a 0.05 level of significance. Mean and standard deviation were calculated to assess the central tendencies and variability of responses. A total of 11 questionnaires were distributed, with 10 returned, reflecting a high retrieval rate of 90.91%. Of the returned questionnaires, 9 were deemed usable for analysis, resulting in a strong utilization rate of 81.82%.

Results and Findings

The findings revealed significant insights into emerging technologies and their impact on the operational effectiveness of librarians in academic libraries.

Research Question 1: How does the adoption of Artificial Intelligence (AI) impact the operational effectiveness of librarians in academic libraries?

Table 1: Summary of Mean and Standard Deviation on the role of Artificial Intelligence (AI) in enhancing operational effectiveness of librarians in academic libraries.

S/N	Item	SA	A	D	SD	X	±	Decision
1	The use of AI has improved the accuracy and speed of cataloging and classifying library resources.	3	5	2	1	3.45	1.06	Agree
2	AI-based chatbots enhance the library's ability to provide timely responses to user inquiries.	2	6	2	1	3.36	1.04	Agree
3	AI helps analyze user preferences, improving decisions for collection development.	1	7	2	1	3.27	1.05	Agree
4	AI-driven predictive analytics optimize resource allocation and service planning.	2	5	3	1	3.27	1.18	Agree
5	AI tools streamline access to digital resources, improving operational effectiveness.	3	4	2	2	3.36	1.11	Agree
Grand Mean						3.34	1.09	

Table 1 reveals that all items related to the role of Artificial Intelligence (AI) in enhancing operational effectiveness in academic libraries received mean scores above 3, indicating a general agreement with the statements. The highest mean score (3.45) was recorded for the item about AI's impact on cataloging and classification, showing strong consensus. The items on AI-driven predictive analytics and AI tools for resource management had the lowest mean scores (3.27), still indicating agreement but suggesting slightly more variation in responses. The standard deviations ranged from 1.04 to 1.18, implying a moderate level of variability in respondents' views. The grand mean of 3.34 confirms that, overall, the respondents agree on the positive impact of AI on operational effectiveness, with slight variation in individual responses. This study's findings harmonize with that of Adebayo et al. (2022) who found that AI technologies, particularly in cataloging and information retrieval, enhance the accuracy, speed, and overall efficiency of library management.

Research Question 2: What is the role of the Internet of Things (IoT) in optimizing librarian effectiveness in academic libraries?

Table 2: Summary of Mean and Standard Deviation on the role of the Internet of Things (IoT) in optimizing librarian effectiveness in academic libraries.

S/N	Item	SA	A	D	SD	X	±	Decision
1	The use of IoT-enabled devices, such as RFID tags and smart shelves, has improved the accuracy of inventory management in academic libraries.	3	2	3	3	2.45	0.82	Agree
2	IoT-based systems for monitoring and controlling energy usage have significantly reduced operational costs in academic libraries.	2	3	4	2	2.45	1.29	Agree
3	The integration of IoT in academic libraries has streamlined library services, enhancing the efficiency of librarians in assisting users.	3	3	3	2	2.64	0.63	Agree
4	Real-time tracking of library resources through IoT has improved the accessibility and availability of materials for library users.	1	2	4	4	2.00	2.00	Agree

S/N	Item	SA	A	D	SD	X	±	Decision
5	The use of IoT-enabled security systems has enhanced the safety and security of library resources and users, reducing the need for manual monitoring.	2	2	3	3	2.09	0.80	Agree
Grand Mean						2.33	1.11	

Table 2 presents data on the role of IoT in improving various operational aspects in academic libraries, with respondents using a four-point Likert scale (Strongly Agree, Agree, Disagree, Strongly Disagree). The mean scores (X) range from 2.00 to 2.64, indicating that respondents generally agreed that IoT applications have positively impacted operational effectiveness. The highest mean score of 2.64 for the third item suggests a particularly strong agreement with the idea that IoT integration enhances librarian efficiency. On the other hand, the lowest mean score of 2.00, related to real-time tracking, still reflects an agreement, but with less emphasis. The standard deviation (\pm) values indicate a moderate to high variation in responses, particularly for the second item ($\pm = 1.29$), which shows significant divergence in opinions. The grand mean of 2.33 further supports the overall consensus that IoT is beneficial in academic libraries, with all items receiving the "Agree" decision, suggesting a favorable outlook on the integration of IoT technologies. Zhang and Yang (2020) found that IoT adoption in libraries can lead to improved operational workflows and enhanced resource management.

Research Question 3: How does the adoption of Virtual Reality (VR) influence librarian effectiveness in academic libraries?

Table 3: Summary of Mean and Standard Deviation on how the adoption of Virtual Reality (VR) in academic libraries influences librarian effectiveness.

S/N	Item	SA	A	D	SD	X	±	Decision
1	Virtual Reality (VR) in academic libraries improves librarian productivity by automating tasks and enhancing user engagement.	2	7	2	0	3.18	0.55	Agree
2	VR in academic libraries increases user engagement through immersive learning and interactive services.	3	6	2	0	3.27	0.48	Agree
3	VR technology enables more efficient access and	1	8	2	0	3.09	0.45	Agree

S/N	Item	SA	A	D	SD	X	±	Decision
	retrieval of information in academic libraries.							
4	VR in academic libraries creates new learning and research opportunities for librarians and users.	3	6	2	0	3.27	0.48	Agree
5	VR promotes more meaningful interactions between librarians and users, encouraging collaboration.	2	7	2	0	3.18	0.55	Agree
Grand Mean						3.20	0.50	Agree

The table summarizes the mean and standard deviation values for various items related to the adoption of Virtual Reality (VR) in academic libraries and its influence on librarian productivity and user engagement. All items received a mean score above 3.0, indicating a general agreement on the positive impact of VR. The scores ranged from 3.09 to 3.27, with the standard deviations varying between 0.45 and 0.55, suggesting a relatively low variation in responses. The highest mean score of 3.27 was associated with the statements that VR increases user engagement through immersive learning and interactive services, and that it creates new learning and research opportunities for both librarians and users. The lowest mean score, 3.09, was for the item about VR enabling more efficient access and retrieval of information. Overall, the grand mean of 3.20 with a standard deviation of 0.50 further supports the consensus that VR adoption positively influences both librarian productivity and user engagement in academic libraries. Salinas et al. (2020) affirmed these findings, highlighting that VR can significantly enhance user interaction and learning experiences while improving librarians' ability to manage information and engage with patrons.

Result of Tested Hypothesis

Table 4: Summary of Pearson Product Moment Correlation (PPMC) on the relationship between Artificial Intelligence and Operational effectiveness of librarians in Academic Libraries

Variables	N	\bar{X}	SD	r	p-value	Decision
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Variables	N	\bar{X}	SD	r	p-value	Decision
Artificial Intelligence	11	3.44	0.70	0.73	0.000	Rejected
Operational effectiveness of librarians		3.50	0.73			

Table 4 presents the results of the Pearson Product Moment Correlation (PPMC) analysis, examining the relationship between Artificial Intelligence (AI) and the operational effectiveness of librarians in academic libraries. The data shows a moderate positive correlation of 0.73 between AI and librarian effectiveness, suggesting a strong relationship between the two variables. With a p-value of 0.000, which is less than the significance level of 0.05, the null hypothesis is rejected, indicating that the correlation is statistically significant. The mean scores for AI ($\bar{X} = 3.44$) and operational effectiveness ($\bar{X} = 3.50$) reflect a favorable perception of both variables. The standard deviations of 0.70 and 0.73 suggest relatively low variability in responses, reinforcing the consistency of the findings. This analysis underscores the potential of AI in enhancing the operational effectiveness of librarians in academic settings.

Discussion of Findings

The findings of this study highlight the transformative impact of emerging technologies on the operational effectiveness of librarians in academic libraries across West Africa. Technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and Virtual Reality (VR) have proven instrumental in optimizing various aspects of library operations. AI has enhanced cataloging efficiency and user personalization, while IoT has improved inventory management and real-time resource tracking, significantly reducing manual workload. VR has opened new avenues for interactive learning and user engagement, creating dynamic experiences for students and researchers. The consistent positive correlation between these technologies and operational effectiveness underscores their pivotal role in driving productivity, improving resource accessibility, and elevating the quality of library services. These findings affirm that the adoption of emerging technologies is not merely a trend but a necessity for academic libraries seeking to remain competitive and relevant in the digital age. This progress promises a brighter future for

librarianship in West Africa, as libraries become more efficient and better equipped to meet the demands of their diverse user communities.

Conclusion

Emerging technologies, particularly Artificial Intelligence (AI), the Internet of Things (IoT), and Virtual Reality (VR), have revolutionized the operational effectiveness of librarians in academic libraries across West Africa. These technologies are not only streamlining library management and enhancing resource accessibility, but they are also fostering greater efficiency in service delivery and user engagement. By automating routine tasks, facilitating real-time tracking of resources, and promoting immersive learning environments, these innovations enable librarians to focus on higher-level tasks, such as user support and research assistance. Moreover, the integration of these technologies is contributing to the reduction of operational costs, the improvement of inventory management, and the enhancement of security protocols, making libraries more dynamic, responsive, and sustainable. As West African academic libraries continue to embrace these emerging technologies, their ability to adapt to the evolving demands of the digital age will be a key driver of future growth and success in the region's higher education sector.

Recommendations

1. Governments and educational institutions should collaborate to invest in and integrate Artificial Intelligence (AI) technologies into academic libraries, providing support for the automation of routine tasks, resource management, and data analytics to enhance operational effectiveness and service delivery.
2. Academic libraries and technology providers should work together to implement Internet of Things (IoT) systems for resource management and real-time tracking, improving the accessibility and availability of library materials.

3. Library management and educational technology developers should prioritize the adoption of Virtual Reality (VR) tools to create immersive learning environments, offering innovative ways for users to engage with content.
4. Academic libraries should invest in staff training and professional development programs focused on emerging technologies like AI, IoT, and VR to ensure librarians are well-equipped to manage and utilize these tools effectively.
5. Governments, educational institutions, and academic libraries should advocate for the creation of funding opportunities and grants to support the integration of emerging technologies in libraries, ensuring financial resources are available for technological advancements.

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