JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

4IR in Academic Libraries: An Exploratory Study of Lusaka Province, Zambia

Kadeyo Mutale Kuyela[1], Akakandelwa Akakandelwa[2], Christine Wamunyima Kanyengo[3]

[1]University Librarian, Chreso University Main Library, Lusaka, Zambia.
[2]Associate Professor of Library and Information Science, School of Education University of Zambia, Lusaka, Zambia.
[3]Senior Librarian, Research, University of Zambia Library, Lusaka, Zambia. https://orcid.org/0000-0003-4249-1859

Abstract
The study examined the extent to which academic libraries have adopted the Fourth Industrial Revolution (4IR) technologies within their library services in academic. A descriptive survey design methodology was employed. The study population consisted of librarians from all academic libraries in both public and private universities in Lusaka Province. The study employed a stratified random sampling and simple random technique, and data was collected using a standard questionnaire with closed-ended questions and analysed using descriptive statistics and inferential statistics. Findings show that digital library repositories (30 respondents, 28.3 percent) emerged as the technology available most commonly in academic libraries, followed by artificial intelligence (20 respondents, 18.9 percent), library social media application (15 respondents, 14.2 percent), and the Internet of Things (IoT) with (13 respondents, 12.3 percent). Other technologies considered with respect to adoption in the libraries included reference management tools (7 respondents, 6.6 percent), a robot library assistant (5 respondents, 4.7 percent), a circulation module (5 respondents, 4.7 percent), big data tools (3, 2.8 percent), 3D modeling software (4, 3.8 percent), blockchain technology (2, 1.9 percent), and a chatbot (2, 1.9 percent), exhibiting varied but limited adoption with respect to the advanced LIB4.0 innovations. The study findings show evidence that the academic libraries are embracing digital repositories and artificial intelligence as key tools to enhance accessibility, operational efficiency, and user engagement in the digital age.

Keywords: Academic Libraries, Africa, Artificial Intelligence, Big Data, Fourth Industrial Revolution, 4IR, Internet of Things, LIB 4.0, Lusaka, Robotics, Zambia,

1.0 Introduction

The Fourth Industrial Revolution (4IR) is characterised by the integration of technologies that blur the boundaries between the physical, digital, and biological realms [1]. This revolution has introduced artificial intelligence, big data analytics, automation, and other innovative technologies that are reshaping traditional processes across various sectors. In the context of library services, these advancements present both challenges and opportunities for academic institutions to adapt and innovate in response to the evolving needs of their users.

The 4IR, as defined by Schwab [2], is a technological shift that merges the boundaries between the physical, digital, and biological worlds. It involves the integration of modern technologies such as artificial intelligence, genetics, machine learning, robotics, nanotechnology, 3D printing, and biotechnology to boost efficiency and productivity across various industries. According to Kamble [3], the 4IR is the continuing transformation of

society and the economy caused by the convergence of digital technologies, artificial intelligence, automation and other emerging technologies.

Libraries, as critical institutions for knowledge transmission and access, have not been spared from the disruptive effects of the 4IR [2]. The application of 4IR to solving the problems of libraries is referred to as Library 4.0 (LIB4.0), whose focus is the integration of digital technology to improve and enhance library services to the community [4]. Anyim [5] postulates that library services are the procedures and operations involved in maintaining, developing and supporting library collections behind the scenes, such as acquisition, cataloguing, classification, interlibrary loan, document delivery and serial systems, as well as the shift toward the digitization of library resources and services. Further, AI has been adopted in the processing of library materials such as in cataloguing [6]; making them sustainable solutions for knowledge organisation and access in libraries [7]. As digital technologies have advanced, libraries have progressively turned to providing electronic resources such as e-books, online journals, and digital archives [3]. This transformation not only increases the accessibility of library materials but also necessitates new skills for librarians to efficiently manage digital collections.

According to Sony and Naik [8], the 4IR has revolutionised information access by allowing distant and seamless retrieval of academic texts. In Zambian, academic libraries have adopted digital repositories and online databases to ensure students and faculty have access to a wide range of academic resources at any time and from any location [9]. Furthermore, advances in data analytics have enabled librarians to evaluate user preferences and behaviours, allowing them to tailor information offerings to the individual needs of library users.

Fakhar Manesh [10] revealed that the 4IR has also brought about a shift in knowledge management, from strategies focused solely on dissemination to those that promote access, knowledge sharing and creative innovations. Academic libraries are expected to keep pace with changes in technology, which are often in a state of flux, and the constantly changing patterns of user behaviour and demand. In a similar vein, Chigwanda and Nwaohiri [9] noted that user expectations regarding library services have shifted. Patrons now demand seamless access to a wide range of digital resources, interactive learning platforms, and personalised assistance from librarians. Libraries must align their offerings with these changing expectations to attract and retain users in an increasingly competitive information landscape.

The 4IR has redefined the role of librarians. Saharkhiz et al. [11] postulates that academic librarians are now required to possess digital literacy skills and expertise in navigating complex information ecosystems. They play a crucial role in guiding users through the vast digital landscape, teaching information literacy skills, and curating digital content. A study by Ayinde and Kirkwood [12] encouraged information professionals to build up their skills and knowledge regarding 4IR technologies to thrive, even though the extent to which these innovations are adopted may differ from one library to another. Additionally, Devi and Bhatt [13] found that technological advancements have transformed research methodology and academic support services in libraries, enabling more sophisticated literature searches, citation analysis, and research data management. Further AI technologies and its application of LI B4.0 technologies has made it possible for libraries to better support research services in a much more user friendly and sustainable way [14]. Lastly, AI has totally transformed digital academic library services making them more accessible and responsible to user needs [15]

2.0 Literature Review

All over the globe, libraries have been acknowledged as institutions that provide for the information needs of individuals who require specific pieces of information for their occupational, educational and personal development. Libraries are dedicated to providing free and equitable access to information for students both in written, electronic or audio-visual form [16]. The 4IR has resulted in substantial changes in information technology, altering a variety of industries, including education and library services [17].

2.1 Integration of Artificial Intelligence

A study done by Sony and Naik [8], revealed that AI holds immense potential for revolutionising library services. Libraries are leveraging artificial intelligence technologies such as powilld chatbots for virtual reference services, enhancing user interactions, and providing real-time assistance. Moreover, AI algorithms are employed for data mining and analysis, enabling libraries to extract valuable insights from vast collections and optimise resource allocation [18]. In this context, Vysakh and Rajendra [19] conducted a study on the integration of artificial intelligence in libraries, and their study revealed that libraries can integrate robotics with other artificial

intelligence technologies like a drone being controlled by a robot that can make sure that the libraries are always under surveillance, by just placing robots in various sections of the library as a user aid and guide.

Xing and Marwala [20] further stated that the 4IR represents a complicated, dialectical, and exciting opportunity for higher education that can reshape society for the better. However, they warn that AI may shift the workplace from task-based to human-centred features. They argue that this may lessen the gap between the humanities and social sciences, as well as science and technology, resulting in a greater demand for interdisciplinary teaching, research, and innovation. The new environment is expected to include virtual classrooms and laboratories, virtual libraries and virtual teachers. That is why Sanji, [21] after looking at the application of artificial intelligence (AI) and chatbots in libraries have concluded that these technologies can help libraries provide personalised services to students and researchers, enhance efficiency and minimise staff workload, making them very beneficial to libraries in providing library and information services to users.

2.2 Utilisation of Big Data Analytics

In recent years, libraries have increasingly used big data analytics to improve their services and operations by harnessing massive amounts of digital data created by library systems, user interactions and other sources (Panda, 2021). It has been argued that the "*integration of 4IR technologies like Artificial Intelligence (AI), Internet of Things (IoT), and big data analytics significantly elevates the importance of KM. It enables organizations to effectively manage and utilize vast data, adapt to evolving skill sets, and optimize operations*" [22]. Likewise in libraries, one important use of big data analytics in libraries is the examination of consumption trends to optimise collection development strategies. Using this AI technology, libraries can discover patron trends and preferences by tracking characteristics like item circulation, database usage and interlibrary loan requests, allowing them to make educated resource purchase and deselection decisions [23]. In Ball [24] study on Big Data usage in libraries, he found that it has a favourable impact on how digital information and communication are managed in Switzerland as it enables them to examine and synthesise vast volumes of data to have a comprehensive picture of their user base's statistics, allowing them to update and improve their environment and services. Similarly, it has been surmised that big data usage improves scholarly work, resulting in cost savings, automation and faster, more accurate conclusions [25].

2.3 Integration of Internet of Things (IoT)

It has been argued that academic libraries can improve user experiences and operational efficiency by utilising the Internet of Things (IoT), through Real-time monitoring of library resources, environmental conditions, and space utilisation that is made possible by the Internet of Things through sensors and devices [26]. According to Singh and Mahajan ([27], radio frequency identification, or RFID, a subset of the Internet of Things that is extensively used in university libraries for self-checkout systems, security and inventory management is another excellent AI technology that can benefit libraries. RFID can overall user experience, make it easier and improve resource allocation across a library or libraries and library layouts can be optimised with the help of the Internet of Things (IoT). AI technology has been used to track and prevent security breaches in libraries [28].

2.4 Implementation of Blockchain Technology

Blockchain technology, another AI technology is gradually making its way into different areas, including libraries, to address long-standing concerns such as data integrity, authentication and transparency[29]. Implementing blockchain technology in libraries has the potential to transform existing library management systems by providing a decentralised and secure platform for managing resources, transactions and intellectual property rights. According to Usman and Ullah[30], blockchain technology can improve the trustworthiness of libraries by ensuring the immutability of records, reducing concerns about data tampering and manipulation.

2.5 Adoption of Augmented Reality (AR) and Virtual Reality (VR)

Virtual reality, another AI technology has been around since the early 1960s, although it has only recently received substantial attention [31]. According to Johnson et al. [32, p. 40], virtual reality is a "computer-generated environment that simulates the physical presence of people and objects to generate realistic sensory experiences". Virtual reality is often defined as an experience in which a person remains physically present in the real world while experiencing a virtual world via a headset and a computer or mobile device [33]. Internationally, libraries have made explicit efforts to make virtual reality available to their customers, as it may be utilised to engage technologically savvy patrons [34].

3.0 Objectives

This study was conducted to determine the extent to which academic libraries have adopted the Fourth Industrial Revolution technologies in library services in academic libraries of Lusaka Province, Zambia.

4.0 Methods

To examine the extent to which academic libraries have adopted the Fourth Industrial Revolution technologies within their library services, a descriptive survey design was employed. The study population consisted of librarians from all academic libraries in both public and private universities in Lusaka Province that were registered with the Higher Education Authority of Zambia as stipulated by the Higher Education Act No. 4 2013 (with amendment Act No. 23 of 2021) [35]/ The study employed a stratified sampling of universities into private and government institution, then followed simple random technique to determine both the sample size of the respondents who would represent the entire population. Data was collected using a standard questionnaire with closed-ended questions and analysed using descriptive and inferential statistics. Descriptive analysis was done by describing events followed by analysis, which not only describes but also provided adequate understanding and explanation of the results.

5.0 Results

5.1 Profile of respondents

To assess the proportion of male and female academic librarians in selected universities in Lusaka Province, the frequency of gender was calculated. The study revealed that 63 (60%) were female and 43 (40%) were male. These findings highlighted that female librarians were more prevalent in this academic setting. The results presented in Table 1 below illustrates the distribution of positions held by 106 librarians within a specific organisation. Among these, the majority were categorised as Librarians 35 (33%), indicating that this role was the most common within the academic library setting in Lusaka province of Zambia. The next largest group consisted of Assistant Librarians 22 (20.8%), followed closely by Senior Library Assistants 17 (16%). Chief Librarians and Deputy Chief Librarians represented a smaller fraction of the workforce, with only 11 (10.4%) and 2 (1.9%) respectively, suggesting that higher managerial roles were less prevalent among this group. Additionally, Library Assistants comprised 19 (17.9%), reflecting a significant support role within the library structure. This distribution highlighted a hierarchical structure where operational roles such as librarians and assistants dominated, while leadership positions were limited.

Table 1: Demographics of respondents

Variables	Values	Frequency	Percentage
Gender	Male	43	40
	Female	63	60
	Total	**106**	**100**
Job Title	Chief Librarian	11	10.4
	Deputy Librarian	2	1.9
	Librarian	35	33.0
	Assistant Librarian	22	20.8
	Senior Library Assistant	17	16.0
	Library Assistant	19	17.9
	Total	**106**	**100**

5.2 Academic Libraries Adoption of the Fourth Industrial Revolution Technologies in Library Services.

As depicted in Table 2, below, respondents were asked to identify the new Library 4.0 (LIB4.0) technologies and applications that were available in their libraries related to the Fourth Industrial Revolution. The study revealed the following results: 20 respondents (18.9%) indicated artificial intelligence, 3 (2.8%) mentioned big data tools, 5 (4.7%) noted a robot library assistant, 2 (1.9%) cited blockchain technology, 13 (12.3%) referred to the Internet of Things (IoT), the majority 30 (28.3%) said digital library repositories, 15 (14.2%) mentioned a library social media platform, 7 (6.6%) indicated reference management tools, 4 (3.8%) referred to 3D modeling software, 2 (1.9%) cited a chatbot, and 5 (4.7%) mentioned a circulation module.

Table 2: Academic libraries adoption of 4IR technologies within their library services

4IR Technology	Frequency	Percent
Artificial intelligence	20	18.9
Big data tools	3	2.8
Robot library assistant	5	4.7
Blockchain technology	2	1.9
Internet of Things (IoT)	13	12.3
Digital library repositories	30	28.3
Library social media platform	15	14.2
Reference management tools	7	6.6
3D modelling software	4	3.8
Chatbot	2	1.9
Circulation module	5	4.7
Total	**106**	**100**

6.0 Discussion

The study's findings highlighted that digital library repositories and artificial intelligence were the tools most adopted by the academic libraries in Lusaka province of Zambia, suggesting that libraries prioritised digital accessibility and advanced data processing to enhance user experience and operational efficiency. In a similar study conducted by Simpson [35], digital repositories enabled libraries to store, manage, and disseminate resources in a structured manner, increasing accessibility for users regardless of their physical location. In an earlier study, AI technologies in libraries were found to be understanding of AI fundamentals among Zambian librarians and positive attitudes towards AI's potential benefits in library services". This shift supported by the United Nations' Sustainable Development Goal 4, which emphasises equitable access to education [36], thereby prioritising digital repositories, libraries demonstrated their commitment to inclusivity and sustainability in the digital age.

Artificial intelligence (AI), reported by 18.9% of respondents, further underscored the academic libraries of Lusaka Province, Zambia in the belief of the power of AI and their efforts to embrace innovative tools for enhancing operational efficiency and user experiences. This finding speaks to those of Alam et al. [37] who stated that "understanding of AI fundamentals among Zambian librarians and positive attitudes towards AI's potential benefits in library services". AI applications in libraries included personalised resource recommendations, automated cataloguing, and advanced data analytics for decision-making [38]. Further, the use of knowledge management practices in the library back-end processes such in cataloguing may help libraries and librarians avoid inconsistencies and duplication of bibliographic records existing in the database and may eventually lead to lead to improved performance levels [39]. As libraries integrated AI, they benefited from reduced administrative workloads and improved service delivery. Omame and Alex-Nmecha [40] highlighted that AI-driven systems in libraries help address the evolving needs of digital-native users by offering intuitive and responsive interactions, thus fostering a more engaging library experience. These are experiences that the libraries surveyed would likely aspire to provide for their library users to enjoy.

7.0 Conclusion

This research highlights the pivotal role of digital repositories and AI in modern libraries, and their increasing growing adoption to drive the improvements that libraries are making so that they can enhance accessibility, operational efficiency, and user engagement in the digital age. By integrating innovative technologies, libraries demonstrate their commitment to inclusivity, sustainability, and adaptability, addressing the evolving needs of modern users. While digital repositories and AI are the most prominent amongst the AI technologies being adopted by academic libraries in Lusaka province of Zambia, other technologies like IoT, social media platforms, 3D modeling software and blockchain are also being explored to optimise resource management, expand outreach, and provide specialised services. This technological evolution positions libraries as dynamic hubs that remain relevant and responsive in an increasingly digitalised world.

8.0 Implications for Practice

The following are the implications for library practice derived from the findings:

1. Academic libraries should enhance accessibility and inclusivity taking advantage of AI.
2. Library management should focus on operational efficiency and user-centric services using AI.
3. Academic libraries should promote technological adaptation and prepare librarians for LIB4.0.

References

[1] K. Schwab, *The Global Competitiveness Report 2010–2011. Geneva: World Economic Forum*. Geneva: World Economic Forum, 2010. Accessed: Mar. 30, 2025. [Online]. Available: https://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2010-11.pdf

[2] K. Schwab, "The Fourth Industrial Revolution: what it means and how to respond," World Economic Forum. Accessed: Mar. 31, 2025. [Online]. Available: https://www.weforum.org/stories/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

[3] S. S. Kamble, A. Gunasekaran, and S. A. Gawankar, "Sustainable Industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives," *Process Safety and Environmental Protection*, vol. 117, pp. 408–425, Jul. 2018, doi: 10.1016/j.psep.2018.05.009.

[4] S. Limwichitr, "Academic Library 4.0 and Beyond: Investigating Adaptation of Academic Libraries in Thailand Towards a 4.0 Landscape," *The Journal of Academic Librarianship*, vol. 50, no. 2, p. 102857, Mar. 2024, doi: 10.1016/j.acalib.2024.102857.

[5] W. Anyim O., "Multimedia instructional resources for effective library user education programme in universities in North-Central Nigeria," *Library Philosophy and Practice (e-journal)*, no. 1821, pp. 1–30, 2018.

[6] O. D. Ogungbenro, U. C. Esse, I. Olowoporoku, and A. Christopher, "Revolutionizing Library Services: The Impact of Artificial Intelligence on Cataloguing and Access to Information in Nigeria Academic Libraries," *Journal of Library Metadata*, pp. 1–20, Mar. 2025, doi: 10.1080/19386389.2025.2475418.

[7] M. Monyela and A. Tella, "Leveraging artificial intelligence for sustainable knowledge organisation in academic libraries," *South African Journal of Libraries and Information Science*, vol. 90, no. 2, Art. no. 2, Aug. 2024, doi: https://doi.org/10.7553/90-2-2396.

[8] M. Sony and S. Naik, "Industry 4.0 integration with socio-technical systems theory: A systematic review and proposed theoretical model," *Technology in Society*, vol. 61, no. 1, p. 101248, May 2020, doi: 10.1016/j.techsoc.2020.101248.

[9] J. P. Chigwada and N. M. Nwaohiri, Eds., *Examining the impact of industry 4.0 on academic libraries*. Emerald Publishing Limited, 2021. doi: 10.1108/9781800436565.

[10] M. Fakhar Manesh, M. M. Pellegrini, G. Marzi, and M. Dabic, "Knowledge Management in the Fourth Industrial Revolution: Mapping the Literature and Scoping Future Avenues," *IEEE Transactions on Engineering Management*, vol. 68, no. 1, pp. 289–300, Feb. 2021, doi: 10.1109/TEM.2019.2963489.

[11] Y. Saharkhiz, M. Valizadeh, and H. Salamat, "The Evolution of Academic Libraries in the Age of Technology," *TAKSAD*, vol. 5, no. 4, pp. 402–415, Jan. 2017, doi: 10.7596/taksad.v5i4.615.

[12] L. Ayinde and H. Kirkwood, "Rethinking the roles and skills of information professionals in the 4th Industrial Revolution," *Business Information Review*, vol. 37, no. 4, pp. 142–153, Dec. 2020, doi: 10.1177/0266382120968057.

[13] G. R. Devi and D. D. Bhatt, "Emerging Technologies and their impact on Resources and Services of Libraries," *Jounral of International Research and Analytical Reviews*, vol. 10, no. 2, pp. 782–785, 2023.

[14] T. R. Wheeler, D. Delgado, P. J. Albert, S. Ben Maamar, and P. R. Oxley, "Transforming and extending library services by embracing technology and collaborations: A case study," *Health Info Libr J*, vol. 39, no. 3, pp. 294–298, Sep. 2022, doi: 10.1111/hir.12439.

[15] M. A. Adarkwah *et al.*, "Exploring the Transformative Journey of Academic Libraries in Africa before and after COVID-19 and in the Generative AI Era," *The Journal of Academic Librarianship*, vol. 50, no. 4, p. 102900, Jul. 2024, doi: 10.1016/j.acalib.2024.102900.

[16] E. C. Uzomba, "Literacy learning spaces, strategies and opportunities in the information age: the role of libraries in creating and enhancing literacy-friendly environment for national development," *Library Philosophy and Practice (e-journal)*, no. 1070, pp. 1–28, 2014.

[17] B. T. David-West, "Fourth Industrial Revolution and Library and Information Science Curriculum Development in Nigeria," *Library Philosophy and Practice (e-journal)*, no. 6702, pp. 1–10, 2021.

[18] S. T. H. Mortaji and S. Shateri, "Harnessing the Power of Business Analytics and Artificial Intelligence: A Roadmap to Data-Driven Success," *International Journal of Innovation in Engineering*, vol. 3, no. 3, Art. no. 3, Sep. 2023, doi: 10.59615/ijie.3.3.1.

[19] C. Vysakh and B. Rajendra, "Application of Artificially Intelligent Robot in Libraries," in *e-Proceedings of the International Conference on Reshaping Librarianship Innovations and Transformations (ICRLIT - 2019) th th 16 & 17 August, 2019*, Tamil Nadu, India: Bharathiar University, 2019. Accessed: Mar. 31, 2025. [Online]. Available:

https://www.researchgate.net/publication/338712408_Application_of_Artificially_Intelligent_Robot_in_Libraries

[20] B. Xing and T. Marwala, "Implications of the Fourth Industrial Age for Higher Education," 2017, *Social Science Research Network, Rochester, NY*: 3225331. Accessed: Mar. 31, 2025. [Online]. Available: https://papers.ssrn.com/abstract=3225331

[21] M. Sanji, H. Behzadi, and G. Gomroki, "Chatbot: an intelligent tool for libraries," *LHTN*, vol. 39, no. 3, pp. 17–20, Mar. 2022, doi: 10.1108/LHTN-01-2021-0002.

[22] W. Padeli, W. A. Mustafa, F. Pangil, K. Abd Kadir, and V. Dwita, "Knowledge Management and the Fourth Industrial Revolution (4IR): A Recent Systematic Review," *J. Adv. Res. Appl. Sci. Eng. Tech.*, vol. 51, no. 2, pp. 18–33, Sep. 2024, doi: 10.37934/araset.51.2.1833.

[23] S. K. Parbie, R. Phuti, and K. A. B. Barfi, "Users' Perception of Library Facilities: Evidence from the University of Cape Coast," *Library Philosophy and Practice (e-journal).*, no. 3784, pp. 1–17, 2021.

[24] R. Ball, "Big Data and Their Impact on Libraries," *AJIST*, vol. 3, no. 1, pp. 1–9, 2019, doi: 10.11648/j.ajist.20190301.11.

[25] F. Xia, W. Wang, T. M. Bekele, and H. Liu, "Big Scholarly Data: A Survey," *IEEE Transactions on Big Data*, vol. 3, no. 1, pp. 18–35, Mar. 2017, doi: 10.1109/TBDATA.2016.2641460.

[26] L. Zhang, "Blockchain: The New Technology and its Applications for Libraries," *Journal of Electronic Resources Librarianship*, vol. 31, no. 4, pp. 278–280, Oct. 2019, doi: 10.1080/1941126X.2019.1670488.

[27] N. Singh and P. Mahajan, "Application of RFID Technology in Libraries," *International Journal of Library and Information Studies*, vol. 4, no. 2, pp. 1–9, 2014.

[28] D. S. Solanke, "RFID Technology in Libraries," *International Journal of Research*, vol. 8, no. 12, pp. 90–97, 2021.

[29] J. Atkinson, *Collaboration and the academic library: internal and external, local and regional, national and international*. Hull, United Kingdom: Elsevier/Chandos Publishing, 2018. doi: 10.1016/C2016-0-03223-0.

[30] M. Usman and A. Ullah, "Blockchain Technology Implementation in Libraries: An Overview of Potential Benefits and Challenges," *AVE technologies in Intelligent Computing Systems*, vol. 1, no. 1, pp. 42–53, 2024.

[31] D. Greene and M. Groenendyk, "An environmental scan of virtual and augmented reality services in academic libraries," *Library Hi Tech*, vol. 39, no. 1, pp. 37–47, Jan. 2020, doi: 10.1108/LHT-08-2019-0166.

[32] L. Johnson, S. Adams Becker, and M. Cummins, *The NMC Horizon Report: 2016 Higher Education Edition*. Toronto, ON, CA: New Media Consortium, 2016. [Online]. Available: https://www.chieflearningofficer.com/wp-content/uploads/2016/02/2016-nmc-horizon-report-he-EN.pdf

[33] J. Hahn, "Virtual Reality Library Environments," in *Mobile Technology and Academic Libraries: Innovative Services for Research and Learning*, Chicago, Illinois: American Library Association, 2017, pp. 237–248. Accessed: Mar. 31, 2025. [Online]. Available: http://hdl.handle.net/2142/96159

[34] B. Massis, "Using virtual and augmented reality in the library," *New Library World*, vol. 116, no. 11/12, pp. 796–799, Nov. 2015, doi: 10.1108/NLW-08-2015-0054.

[35] R. Simpson, "Formalised responsibility modelling for automated socio-technical systems analysis," PhD, School of Computing Science College of Science and Engineering University of Glasgow, Glasgow, Scotland, 2017. Accessed: Mar. 31, 2025. [Online]. Available: https://eleanor.lib.gla.ac.uk/record=b3288239

[36] UNESCO, "Sustainable Development Goal 4 (SDG4) | #LeadingSDG4 | Education2030," UNESCO. Accessed: Mar. 31, 2025. [Online]. Available: https://www.unesco.org/sdg4education2030/en/sdg4

[37] A. F. Alam, A. Subaveerapandiyan, D. Mvula, and N. Tiwary, "AI Literacy and Zambian Librarians: A Study of Perceptions and Applications," *Open Information Science*, vol. 8, no. 1, pp. 18–21, Jan. 2024, doi: 10.1515/opis-2022-0166.

[38] J. E. Ajakaye, "Applications of Artificial Intelligence (AI) in Libraries," in *Advances in Library and Information Science*, I. I. Ekoja, E. F. Ogbomo, and O. Okuonghae, Eds., IGI Global, 2022, pp. 73–90. doi: 10.4018/978-1-7998-9094-2.ch006.

[39] E. M. M. Chitumbo and C. W. Kanyengo, "Knowledge Management Culture among Library Cataloguers: the University of Zambia Library Experience," *Library Philosophy and Practice (e-journal)*, no. 1561, pp. 1–16, 2017.

[40] I. M. Omame and J. C. Alex-Nmecha, "Artificial Intelligence in Libraries," in *Advances in Library and Information Science*, N. E. Osuigwe, Ed., Hershey, Pennsylvania, USA: IGI Global, 2020, pp. 120–144. Accessed: Mar. 31, 2025. [Online]. Available: http://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/978-1-7998-1116-9.ch008