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Navigating the future of academic library services: barriers to adopting 4IR technologies in academic libraries in Zambia

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Abstract

To establish the challenges academic libraries, face in adopting the Fourth Industrial Revolution technologies in library services in Lusaka Province of Zambia. The methodology adopted was a descriptive survey design. 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 single random sampling technique, whilst data was collected using a standard questionnaire with closedended questions and analysed using descriptive statistics and inferential statistics. The study revealed that 37 respondents (34.9%), indicated a lack of funding. 22 (20.8%) cited insufficient training for staff, while 6 (5.7%) mentioned resistance to change among staff. 15 (14.2%) reported inadequate technical infrastructure, and 10 (9.4%) noted a limited understanding of technologies. 4 (3.8%) expressed fear of losing their jobs as new technology emerged, and 12 (11.3%) indicated a lack of ICT skillsets necessary to utilise Library 4.0 technologies. Altogether, these challenges indicated that successful integration required comprehensive support in financial, technical, and human resources to equip libraries for the digital shift. The study highlighted that the successful integration of emerging technologies in libraries, such as Library 4.0 tools, requires addressing several critical challenges, including financial constraints, insufficient staff training, inadequate technical infrastructure, and resistance to change. A lack of ICT skills, limited understanding of technologies, and fears of job insecurity further hinder adoption.

Keywords: Academic Libraries, 4IR, Fourth Industrial Revolution, LIB 4.0, Infrastructure, Institutional repositories, Librarians, Resistance to change, 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; and when these technologies are applied to library processes



and services, they are referred to as LIB 4.0 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.

Libraries, as critical institutions for knowledge transmission and access, have not been spared from the disruptive effects of the 4IR [1]. Anyim [2] 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 digitisation of library resources and services. 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 as necessity in order to preserve the integrity of the information that are in the library collections and ensure permanent access to that information [4].

The effect of the 4IR on academic library services is evident in several ways. Initially, there has been a shift toward digital collections and resources, with libraries progressively adopting digital platforms for organising, archiving and providing access to a diverse range of electronic resources such as e-books, e-journals, and online databases [5, p. 44], [6, p. 4], [7]. Furthermore, the use of automation technology has improved library operations by increasing efficiency in tasks such as inventory management and resource retrieval [8].

Fakher Manesh [9] 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, Chigwada and Nwaohiri [6] 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 [10], [11].

2.0 Literature Review

Over the last three decades, the realisation that technology will be a major determinant of the quality of education has contributed to a redefinition of the role of libraries. The evolution of information and learning environments has pushed libraries to adapt and change. This is in stark contrast to the previous few centuries when libraries were rather stagnant organisations. The rate at which technological change is accelerating, and the adoption of technology in libraries has no end in sight. This is because technology is not static; it is ever-changing. Each new generation of technology becomes outdated several times faster than the previous generation [12].

2.1 Financial Constraints

One of the biggest barriers to libraries adopting 4IR technology is the financial burden associated with procuring and deploying these advanced technologies [12]. Many academic institutions find it



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prohibitively expensive to purchase and operate cutting-edge technologies such as artificial intelligence (AI) systems, virtual reality (VR) tools, and data analytics platforms[6], [13]. Some author also agree that, while in some countries such as South Africa are renowned as one of Africa's top countries for embracing modern technology and innovation, they are hampered by a lack of funds, which may hinder the implementation of 4IR in teaching and learning[13], [14]. Similarly, Mohideen [12], who researched Malaysian librarians' perspectives of the 4IR, discovered that the COVID-19 pandemic would worsen financial conditions and impede libraries' ability to deploy 4IR technologies. It was also predicted that the COVID-19 pandemic had a significant negative influence on higher education, as revenue was reduced and academic libraries' dreams of embracing Lib 4.0 technologies was not realised[5], [15], [16]. However, the pandemic presented an opportunity for libraries to participate in remote delivery of services [15] and be involved in e-learning and provides services for learning management systems such as Moodle for teaching and learning at their institutions [17].

2.2 Lack of Technical Expertise

Another key difficulty identified by Jain (2023) is a shortage of technical skills among library workers to successfully use and administer 4IR technology. Implementing technology such as machine learning algorithms or blockchain systems necessitates specialised knowledge and skills, which may not be readily available in typical library environments. In their study on supporting teaching, learning, research, and recreation, also argued that library staff should have specialised skills that improve the delivery of effective library and information services to meet the changing needs of university clients [13], [18], [19].

2.3 Privacy and Data Security Concerns

The introduction of 4IR technology into academic libraries poses serious privacy and data security concerns. Technologies like IoT devices and cloud computing solutions capture massive volumes of user data, prompting concerns about data security, confidentiality, and General Data Protection Regulation (GDPR) compliance [20]. Limited financial resources, a lack of technological experience among library staff, and concerns about data privacy and security are key impediments to the widespread adoption of these technologies [21].

According to, one of the most pressing concerns in libraries is the acquisition and preservation of personally identifiable information (PII) about library users. This includes information such as names, addresses, and borrowing histories, which are frequently required for library services but might pose privacy hazards if handled improperly [22], [23]. Libraries must maintain stringent confidentiality regulations to protect patrons' privacy rights. According to the American Library Association's (ALA) rules, libraries should only gather data that is required for library operations and keep it secure from unauthorised access [24]. Implementing anonymization techniques and data minimisation strategies can help to avoid these risks while maintaining critical library operations [25]. It is also critical that due to a lot of proliferation of information, the digital require permanent preservation so as to guarantee permanent access to users [4].

2.4 Infrastructure Limitations

Ocholla and Ocholla [26] investigated the responsiveness of South African libraries to research support in the 4IR and established that in general the libraries were responding well the 4IR through their services,



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whilst Manda and Ben Dhaou [27] investigated the problems and opportunities in the 4IR in developing nations, and that despite the challenges they were embracing the opportunities offered by the 4IR. Further, the research discovered that a lack of ICTs, limited broadband for internet connectivity, a lack of high-tech equipment, and poor digital connectivity were impeding the seamless transition to smart societies, particularly in the library. The authors also expected that many university libraries face significant challenges in implementing Lib 4.0 due to inadequate ICT infrastructure [27]. Khan and Bhatti's [28] investigation in Pakistan found that the libraries were faced with similar challenges.

3.0 Objectives

This study was conducted to establish the challenges academic libraries face in adopting the Fourth Industrial Revolution technologies in their library services taking a case of academic libraries in Lusaka Province, Zambia.

4.0 Methods

To establish the challenges academic libraries, face in adopting the Fourth Industrial Revolution technologies in 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 Act No. 23 of 2021 [29]. The study employed a stratified random sampling technique to determine both the sample size and the respondents who would represent the entire population. Data was collected using a standard questionnaire with closed-ended questions and analysed using descriptive statistics.

5.0 Results

5.1 Profile of respondents

The type of gender distribution and hierarchies of academic librarians in selected universities in Lusaka Province were analysed in this study. Results showed a larger representation of females, with 63 (60%) females and 43 (40%) males. Of the total 106 librarians surveyed, most were in the mid-level roles of Librarian (35 respondents, 33%), Assistant Librarian (22 respondents, 20.8%), and Senior Library Assistant (17 respondents, 16.0%). Few librarians held top management roles. Additionally, they were also staff in high academic leadership positions: Chief Librarian (11 respondents, 10.4%) and Deputy Chief Librarian (2 respondents, 1.9%). Library Assistant represented 19 (17.9%) of the staff, which suggests that the composition of the workforce in academic libraries in Lusaka is biased towards operational positions, rather than supervisory or managerial roles.

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

Table 1: Demographics of respondents



Total	106	100
Library Assistant	19	17.9
Senior Library Assistant	17	16.0

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5.2. Respondents Working Departments

As portrayed in Table 2 below, the respondents were asked to identify the department they worked in. Out of the total sample 106, the majority 26 (24.5%) worked in the department of reference services, 9 (8.5%) in electronic resources, 13 (12.3%) in the information technology support unit, 17 (16%) in the cataloguing department, 10 (9.4%) in the acquisition department, 7 (6.6%) in the institutional repository, and 9 (8.5%) in administration. These findings revealed that the department of reference services had the highest representation among respondents, indicating a strong emphasis on direct user assistance and information retrieval.

Table 2: Working Department

Department	Frequency	Percent
Reference services	26	24.5
Electronic resources	9	8.5
Information Technology support unit	13	12.3
Cataloguing	17	16.0
Circulation	15	14.2
Acquisition	10	9.4
Institutional repository	7	6.6
Administration	9	8.5
Total	106	100.0

Source: Formulated by Author (2024)

5.3 Level of Technological Adoption in Libraries

In Figure 1 below, the respondents were asked to rate the level of technological adoption in their libraries. The results showed that 11 respondents (10%) rated it as very high, 38 (36%) rated it as high, the majority 49 (46%) rated it as moderate, and 8 (8%) rated it as low. These findings suggested that most respondents had perceived the level of technological adoption in their libraries as moderate or high, indicating that the majority of the academic libraries in Lusaka province of Zambia were steadily adopting the 4IR.

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Figure 1: Technological adoption in libraries

5.4 Adoption Challenges of 4IR Technologies in Academic Libraries

The study in Table 3 found that the majority, 37 respondents (34.9%), indicated a lack of funding. 22 (20.8%) cited insufficient training for staff, while 6 (5.7%) mentioned resistance to change among staff. 15 (14.2%) reported inadequate technical infrastructure, and 10 (9.4%) noted a limited understanding of technologies. 4 (3.8%) expressed fear of losing their jobs as new technology emerged, and 12 (11.3%) indicated a lack of ICT skill sets necessary to utilise Library 4.0 technologies. Altogether, these challenges indicated that successful integration required comprehensive support in financial, technical, and human resources to equip and ensure that the academic libraries in Lusaka Province of Zambia were ready for the digital shift.

Challenges	Frequency	Percent
Lack of funding	37	34.9
Insufficient training for staff	22	20.8
Resistance to change among staff	6	5.7
Inadequate technical infrastructure	15	14.2
Limited understanding of technologies	10	9.4
Fear of losing my job as new technology emerges	4	3.8
Lack of ICT skillset to utilise Library 4.0 technologies	12	11.3
Total	106	100.0

Table 3: Adoption Challenges of 4IR Technologies in Academic Libraries

6.0 Discussion

The results highlight a number of important implications in terms of adoption and barriers preventing the successful adoption of Lib 4.0 technologies.



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6.1 Level of 4IR adoption in academic libraries in Lusaka Province, Zambia

These results suggest that most of the academic libraries in Lusaka province, Zambia, are constantly progressing in embracing the fourth industrial revolution (4IR) technologies. The findings of a combined 82% of respondents (combination of 'medium,' high, 'and' very high 'ratings) indicate a positive tendency towards acknowledgement and recognised digital changes as critical to library operations and service provision. However, the predominance of the moderate rating (46%) means that while the progress is clear, there is still a place to improve advanced technologies such as AI-operated systems, IOT, Big Data Analytics and automation in the academic libraries of Lusaka Province Zambia. The 8% who rated adoption as low may reflect disparities in resource allocation, funding constraints, or varying institutional priorities among different libraries.

This highlights the need for minority targeted interventions, such as digital infrastructure to ensure equal technological advancement in all academic libraries, increase in investment in employees training and policy assistance. Overall, findings align with global trends where academic libraries are gently integrating 4IR technologies to increase service distribution, research support and user access [6], [10], [14], [30], [31].

However, continuous efforts - including technical providers, government assistance and continuous professional development working in collaboration and partnership with other institution - will be important to accelerate adoption and ensure that Lusaka's academic library remains competitive in the digital age. In general, the findings speak to similar situations in other regions of the world and particularly sub-Saharan Africa [5], [13], [26], [28].

6.2 Challenges Hindering Technological Adoption in Academic Libraries

The findings in the survey reveal a number of challenges preventing the academic libraries in Lusaka Province, Zambia from fully implementing Library 4.0 technologies.

6.2.1 Funding

The study found that the 37 respondents (34.9%), indicated a lack of funding as one of the biggest challenges being faced by libraries in relation to adoption of 4IR technologies. This is a result of budget limitations which prevent libraries from spending money on critical library information technology infrastructure like software and training programmes that are necessary to power the digital transformation of libraries [13]. Insufficient funding can hinder libraries from getting new, innovative devices, including artificial intelligence (AI), the Internet of Things (IoT), and blockchain, crucial parts of Library 4.0 [32]. Therefore, the most significant challenge to full implementation noted by the majority of respondents (34.9%; n=37) was lack of funding, demonstrating an importance of funding in digital transformation. Without adequate funding libraries are not able to invest in new technologies, infrastructure update, or sustain digital initiatives. Usman and Ullah [33] revealed that inadequate financial resources could hinder libraries' ability to invest in the infrastructure and tools needed for the adoption of technologies associated with the 4IR, including digital catalogues, artificial intelligence, and virtual reality.



6.2.1 Insufficient Training

Lack of proper training of staff was another significant issue, reported by 22 (20.8%) of the respondents, which indicates that even when the technologies are available, librarians may lack the necessary skills to utilise their potential. This is the same percentage of 12 (11.3%) respondents that reported a lack of ICT skill sets as a significant barrier. The rapid evolution of 4IR technologies (AI, IoT, big data, etc.) necessitates continuous professional development, but formal training programmes may not be available in many schools to bridge this gap. In a similar studies it was established that most libraries are not yet ready in terms of insufficient knowledge of emerging technologies to adequately embrace and integrate 4IR technologies in their libraries [7], [18], [19], [26], [34].

6.2.3 Resistance to Change

In addition, resistance to change (5.7%) and fear of job loss (3.8%) demonstrate psychological and organisational barriers towards embracing technology. Even though they were less prevalent, they underscore the necessity for mindset shifts and change management strategies in order to foster a culture of innovation to fully embrace and integrate 4IR technologies in academic libraries in Lusaka province of Zambia, reflecting similar results in other regions of the world [13], [35], [36].

6.2.4 Insufficient Infrastructure

Infrastructure constraints were another key issue, with 15 (14.2%) of the respondents) stating a lack of technical infrastructure, and 10 (9.4%) of the respondents citing insufficient knowledge of new technologies. This indicates that as well as a lack of funding, libraries are confronted with logistics and knowledge-related challenges in leveraging digital solutions successfully for the successful implementation of 4IR technologies in Lusaka province academic libraries. These findings are supported by earlier research, which reports that an overwhelming majority of scholarly libraries in the developing world suffer not only financial difficulties but also not enough LIB 4.0 technologies to power the digital transformation of their libraries [4], [37], [38].

6.2.5 Knowledge Gaps and Workforce Anxiety in LIB 4.0 Technology Adoption

Of the study population, 10(9.4%) respondents cited insufficient knowledge of emerging technologies as a major barrier to digital transformation within their libraries. This knowledge gap assumes historical importance in the context of Library 4.0, with AI, IoT, and big data analytics now being vital and integral features of modern library services [7], [18]. The comprehensiveness of these tools is crucial for library employees to adopt or recommend their use; otherwise, institutional movement toward digital readiness would be difficult to achieve [6], [32], [38], [39].

Another 4(3.8%) respondents mentioned the fear of job loss that technological innovation would cause, which is a well-documented phenomenon in automation-anxiety studies [40]. While it may look small in immediacy, the percentage points to a significant psychological barrier to technology acceptance. Concerns about job security will usually be expressed in such reluctance to even attempt new systems or active opposition to digital initiatives [32], [40], [41].



7.0 Conclusion

The study highlights that the successful integration of emerging technologies in libraries, such as Library 4.0 tools, requires addressing several critical challenges, including financial constraints, insufficient staff training, inadequate technical infrastructure, and resistance to change. A lack of ICT skills, limited understanding of technologies, and fears of job insecurity further hinder adoption. These findings underscore the importance of comprehensive support in financial, technical and human resources to enable libraries to adapt effectively to the digital transformation and leverage advanced technologies to enhance their services.

8.0 Policy and Practice Implications

The challenges arising out of the study indicate that a multifaceted strategy is necessary for successful technology integration of LIB 4.0:

8.1 Increase funding and resource allocation: library management should focus on the strategic allocation of resources, as it is critical to success of future library services including providing for sufficient infrastructures to underpin the services.

8.2 Capacity building and training: academic libraries should emphasise continuous training and development; but also demisting the idea and fear that librarians will lose their jobs once library deploy LIB 4.0 technologies.

8.3 Change management strategies: library management should implement effective change management strategies to help mitigate resistance and effects of transitions.

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