

AI Algorithm Fairness and Bias in Academic Library Information Systems: A Study of Ramat Library, University of Maiduguri, Borno State, Nigeria

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Abstract - This study examined artificial intelligence algorithm fairness and bias in academic library information systems at Ramat Library, University of Maiduguri, Borno State, Nigeria. A descriptive survey design was used. The study involved 152 library professionals and 385 library users. Data were collected using structured questionnaires assessing AI-driven service implementation, awareness of algorithmic bias, user perceptions, and institutional gaps. Descriptive statistics, Pearson product-moment correlation, and an independent-samples t-test were used for analysis. AI-driven service implementation was moderate (mean = 2.62, SD = 0.91), while awareness of algorithmic bias among library professionals was also moderate (mean = 2.59, SD = 0.87). Users generally perceived AI search results as fair, but reported weaker representation of local and Indigenous knowledge and multilingual materials. Institutional gaps were rated high (mean = 3.37, SD = 0.82), particularly the absence of an AI governance policy and bias-auditing protocols. A significant positive association was observed between AI service implementation and awareness of algorithmic bias ($r = 0.387$, $p < 0.001$), whereas no significant difference was found in bias perceptions by gender ($t = 1.24$, $p = 0.216$). The findings support the need for context-sensitive AI governance, staff capacity building, bias auditing, participatory oversight, and improved multilingual and Indigenous knowledge representation in academic library information systems.

Keywords - Artificial intelligence; Algorithmic bias; Algorithmic fairness; Academic libraries; Information retrieval; Epistemic justice; Nigeria

I. INTRODUCTION

A. Background to the Study

The global adoption of artificial intelligence (AI) in academic libraries has accelerated, transforming how information is discovered, accessed, and managed. AI-supported catalogue search, chatbot-assisted reference services, natural language processing, and machine learning-based recommendation systems are being explored or deployed to improve information discovery and service delivery. Recent systematic and scoping reviews show that reference and information services, technical services, and related discovery functions are among the principal areas of AI adoption in academic libraries. ([4]; [5])

Algorithmic bias in library information systems can arise through biased training data, unequal representation, ranking and recommendation processes, and limited transparency. In library contexts, these issues may affect the discoverability and representation of scholarship, particularly where languages, communities, or knowledge traditions are underrepresented in the underlying data. ([5]; [1])

Ramat Library, University of Maiduguri, Borno State, Nigeria, provides a relevant context for examining these issues. The library was established in 1975 alongside the University of Maiduguri and has developed into a major academic library serving the university community. Historical and institutional sources document its development, collections, electronic library services, and role in supporting teaching, learning, and research. ([9]; [11])

The University of Maiduguri is located in Borno State, northeastern Nigeria, a region that has experienced substantial security and socioeconomic challenges. Within this setting, Ramat Library supports educational continuity, research, and access to scholarly information. Recent work on the library's digital preservation initiatives also highlights the importance of documenting and making Indigenous knowledge accessible through digital technologies. [10]

B. Statement of the Problem

The adoption of AI in Nigerian academic libraries is developing, but the extent and type of adoption vary across institutions. Recent reviews identify funding, infrastructure, staff capacity, training, and governance as important challenges to AI adoption in academic libraries. However, empirical evidence concerning algorithmic fairness and bias in specific Nigerian academic library settings remains limited. ([4]; [5])

At Ramat Library, AI-driven service implementation is still developing, while institutional capacity for identifying, assessing, and mitigating algorithmic bias requires further strengthening. The absence of a clearly documented, locally grounded AI governance framework may also make it difficult to address linguistic, cultural, and epistemic considerations systematically. These concerns are consistent with recent African library research that calls for locally relevant AI governance and greater staff participation in AI-related decision-making. [6]

This study, therefore, addresses a critical gap by investigating AI algorithm fairness and bias specifically within the context of Ramat Library. It seeks to understand the current state of AI implementation, the levels of bias awareness among library professionals and users, and the institutional frameworks (or lack thereof) for ensuring algorithmic fairness.

C. Objectives of the Study

The specific objectives of this study are to:

Examine the extent of AI-driven service implementation at Ramat Library, University of Maiduguri.

Assess the level of awareness of AI algorithm fairness and bias among library professionals at Ramat Library.

Investigate the perceptions of algorithmic bias among library users at Ramat Library.

Identify the challenges and institutional gaps affecting the ethical deployment of AI systems at Ramat Library.

Propose a locally grounded framework for mitigating algorithmic bias in academic library information systems.

D. Research Questions

The following research questions guided the study:

What is the extent of AI-driven service implementation at Ramat Library?

What is the level of awareness of AI algorithm fairness and bias among library professionals at Ramat Library?

How do library users at Ramat Library perceive algorithmic bias in AI-powered information services?

What institutional gaps exist in addressing AI algorithm fairness and bias at Ramat Library?

What locally grounded framework can be developed to mitigate algorithmic bias in academic library information systems?

E. Significance of the Study

This study contributes to scholarship on ethical AI in library and information science, particularly in the Global South. It provides empirical evidence on AI implementation, algorithmic-bias awareness, user perceptions, and institutional gaps at a Nigerian academic library. The findings may assist library administrators, policymakers, and professional bodies in developing context-sensitive approaches to AI governance, staff development, bias auditing, and equitable information access.

II. LITERATURE REVIEW

A. Theoretical Framework: Algorithmic Fairness and Epistemic Justice

This study is anchored in two complementary perspectives: algorithmic fairness and epistemic justice. Algorithmic fairness concerns whether AI systems produce or support equitable outcomes and whether their development and

evaluation processes adequately account for potentially disadvantaged groups. In AI research and governance, fairness is commonly considered alongside accountability, transparency, and ethical responsibility. In library information systems, these principles can be operationalised through attention to data representation, retrieval performance, ranking and recommendation, documentation, and human oversight. ([2]; [5])

Epistemic justice, as applied to library contexts, concerns the fair recognition and treatment of different knowledge systems and the ability of communities to participate in knowledge production, description, and access. Recent research on South African academic libraries identifies epistemic justice, transparency, data sovereignty, multilingual equity, and participatory stewardship as important considerations for locally grounded ethical AI governance. [6]

B. AI Adoption in Nigerian Academic Libraries

AI adoption in Nigerian academic libraries is developing across areas such as reference and information services, technical services, administrative functions, collection development, and information literacy. A recent systematic review of academic-library AI adoption identified reference and information services as a prominent area of application and highlighted funding and staff retraining as important institutional challenges. Nigerian research also points to growing interest in AI-enabled information retrieval and related services. ([4]; [8])

At the University of Maiduguri, Wada et al. (2026) reported that AI-driven service implementation was low ($\bar{X} = 2.68$, $SD = 0.91$), whereas user discovery and information access were moderately high ($\bar{X} = 3.40$, $SD = 0.89$). They also reported a statistically significant moderate positive relationship between AI-driven service implementation and user discovery and information access ($r = 0.432$, $p < 0.001$). These findings provide local evidence that AI-enabled services are developing at the institution and that their implementation is associated with information-discovery outcomes, while not establishing a causal relationship.

C. Algorithmic Bias in Library Information Systems

The literature identifies several mechanisms through which algorithmic bias can affect information retrieval and library services. Aly Ibrahim (2025) discusses data bias and user representation, algorithmic transparency, explainability, privacy, accessibility, and user participation as important ethical considerations for AI-powered libraries. These concerns are consistent with the broader literature on bias in information retrieval systems. ([1]; [5])

Igbinovia and Danquah (2025), in a scoping review of 76 peer-reviewed studies, found that AI bias in information retrieval can be associated with biased training data, unfair representation, and limited transparency. They emphasised the role of LIS professionals in bias detection, ethical data curation, auditing, collaboration, and policy development. Nigerian research among LIS students also reports a significant relationship between awareness of AI algorithmic bias, ethical concerns, and AI use for information retrieval. ([5]; [8])

D. Ethical AI Frameworks for African Academic Libraries

Recent research has begun to develop ethical AI frameworks specifically for African academic library contexts. Mdhlalose (2026) proposes a locally grounded Ethical AI Integration Framework centred on epistemic justice, algorithmic transparency, data sovereignty, multilingual equity, and participatory stewardship. Such approaches emphasise the importance of adapting AI governance to local institutional, linguistic, cultural, and knowledge contexts rather than relying exclusively on frameworks developed elsewhere.

More broadly, FATE-related approaches in AI research emphasise fairness, accountability, transparency, and ethics as complementary dimensions of responsible AI. For library data curation and information retrieval, these principles can be translated into practical checkpoints across data selection, documentation, preservation, retrieval, dissemination, and evaluation. ([2]; [5])

E. The Context of Ramat Library, University of Maiduguri

Ramat Library has been examined in studies of its collections, services, technology infrastructure, and digital initiatives. Research has documented challenges in managing technology facilities and promoting service delivery, including constraints related to funding, infrastructure, staff skills, training, and policy. [3]

The digital preservation of Indigenous knowledge at Ramat Library has also been documented as an important initiative for improving the long-term accessibility of local knowledge. However, the existing literature identified in this study does not specifically examine algorithmic fairness and bias within AI-powered library information systems at Ramat Library. This study therefore addresses a specific empirical gap. [10]

III. METHODOLOGY

A. Research Design

The study adopted a descriptive survey research design to collect data on the existing state of AI-driven services, awareness of algorithmic bias, user perceptions, and institutional gaps at Ramat Library. A descriptive survey is appropriate for describing characteristics, perceptions, and practices within a defined population.

B. Population and Sampling

The target population comprised two distinct groups: Library professionals at Ramat Library, including librarians, cataloguers, system librarians, and library officers. A total of 152 professionals were purposively sampled based on their involvement in library technology and information services. Active library users registered at Ramat Library, including undergraduate and postgraduate students, academic staff, and researchers. A total of 385 users were sampled using stratified random sampling to improve representation across faculties and user categories. The sample size was determined using the Raosoft Sample Size Calculator at a 95% confidence level and a 5% margin of error.

C. Research Instruments

Two structured questionnaires were developed for data collection:

AI Fairness Awareness Questionnaire for Library Professionals (AFAQ-LP): This 42-item instrument covered demographic information, extent of AI implementation, awareness of algorithmic bias concepts, institutional readiness, and perceived challenges.

AI Bias Perception Questionnaire for Library Users (ABPQ-LU): This 28-item instrument assessed users' experiences with AI-powered library services, awareness of algorithmic bias, and perceptions of fairness in information access.

D. Validity and Reliability

Both instruments were subjected to face and content validity by three experts in Library and Information Science and one expert in Research Methodology. A pilot study was conducted with 20 library professionals and 30 library users who were not part of the main study. The reliability coefficients obtained using Cronbach's alpha were 0.89 for AFAQ-LP and 0.85 for ABPQ-LU, indicating high internal consistency.

E. Data Collection Procedure

Data were collected over a period of six weeks. Questionnaires were administered physically at Ramat Library, while online versions were distributed by email to library professionals and user representatives. The researchers obtained institutional permission from the University Librarian and obtained informed consent from participants. Anonymity and confidentiality were maintained throughout the data-collection process.

F. Data Analysis

Data were analysed using descriptive and inferential statistics. Descriptive statistics included frequency counts, percentages, means, and standard deviations. Mean scores were interpreted using a criterion mean of 2.50: item means of 2.50 and above were classified as 'agreed' or 'high', whereas means below 2.50 were classified as 'disagreed' or 'low'. Inferential statistics, including Pearson's product-moment correlation and the independent-samples t-test, were used to test the hypotheses at the 0.05 level of significance. Statistical analysis was performed using SPSS version 26.

IV. FINDINGS

A. Demographic Characteristics of Respondents

TABLE I. DEMOGRAPHIC CHARACTERISTICS OF LIBRARY PROFESSIONALS (N = 152)

Variable	Category	Frequency	Percentage
Gender	Male	78	51.3%
	Female	74	48.7%
Age	20–35 years	42	27.6%
	36–50 years	76	50.0%
	Above 50 years	34	22.4%
Education	Bachelor's degree	68	44.7%

	Master's degree	62	40.8%
	PhD	22	14.5%
Years of Experience	1–10 years	56	36.8%
	11–20 years	64	42.1%
	Above 20 years	32	21.1%

B. Research Question 1: Extent of AI-Driven Service Implementation at Ramat Library

TABLE III. EXTENT OF AI-DRIVEN SERVICE IMPLEMENTATION (N = 152)

AI Service	Mean	SD	Decision
AI-powered catalogue search	3.12	0.94	Agreed
Chatbot-assisted reference services	2.45	1.02	Disagreed
Machine learning-based recommendation	2.18	0.96	Disagreed
Natural language processing tools	2.34	1.05	Disagreed
Automated cataloguing and classification	2.56	0.98	Agreed
AI-based plagiarism detection (Turnitin)	3.67	0.82	Agreed
Predictive analytics for collection development	2.05	0.91	Disagreed
Overall Mean	2.62	0.91	Moderate

The findings show that AI-driven service implementation at Ramat Library was moderate overall ($\bar{X} = 2.62$, $SD = 0.91$). The most widely implemented service was AI-based plagiarism detection through Turnitin ($\bar{X} = 3.67$, $SD = 0.82$), followed by AI-powered catalogue search ($\bar{X} = 3.12$, $SD = 0.94$) and automated cataloguing and classification ($\bar{X} = 2.56$, $SD = 0.98$). The pattern is broadly consistent with recent literature showing that academic libraries are adopting AI across specific service areas rather than through a single, integrated model. [4]

C. Research Question 2: Awareness of AI Algorithm Fairness and Bias Among Library Professionals

TABLE IV. AWARENESS OF ALGORITHMIC BIAS CONCEPTS (N = 152)

Item	Mean	SD	Decision
I am familiar with the concept of algorithmic bias	3.24	0.88	High
I understand how AI systems can perpetuate data bias	3.08	0.92	High
I am aware of fairness auditing methods for AI systems	2.42	1.04	Low
I know about Explainable AI (XAI) principles	2.28	1.08	Low
I can identify potential bias in search algorithms	2.56	0.96	Moderate
I understand the concept of epistemic justice in AI	2.18	1.02	Low
I am familiar with the FATE principles	2.34	0.98	Low
Overall Mean	2.59	0.87	Moderate

The results indicate that library professionals at Ramat Library demonstrated moderate overall awareness of algorithmic bias ($\bar{X} = 2.59$, $SD = 0.87$), with notable gaps in technical aspects of bias mitigation. Professionals reported relatively high awareness of basic concepts such as algorithmic bias ($\bar{X} = 3.24$, $SD = 0.88$) and data bias ($\bar{X} = 3.08$, $SD = 0.92$), but lower awareness of fairness auditing methods ($\bar{X} = 2.42$, $SD = 1.04$), Explainable AI principles ($\bar{X} = 2.28$, $SD = 1.08$), and epistemic justice ($\bar{X} = 2.18$, $SD = 1.02$).

D. Research Question 3: User Perceptions of Algorithmic Bias

TABLE V. USER PERCEPTIONS OF ALGORITHMIC BIAS (N = 385)

Item	Mean	SD	Decision
AI search results seem fair and unbiased	3.42	0.86	Agreed
I have noticed missing results for certain topics	2.18	0.94	Disagreed
Local/Indigenous knowledge is well represented	2.34	1.02	Disagreed
AI recommendations match my information needs	3.28	0.91	Agreed
I am aware of how AI affects my search results	2.12	0.98	Disagreed
Multilingual materials are adequately retrieved	2.45	1.05	Disagreed
Overall Mean	2.63	0.84	Moderate

User perceptions indicate that respondents generally viewed AI search results as fair ($\bar{X} = 3.42$, $SD = 0.86$), while reporting weaker representation of local or Indigenous knowledge ($\bar{X} = 2.34$, $SD = 1.02$) and multilingual materials ($\bar{X} = 2.45$, $SD = 1.05$). This apparent tension suggests that users may perceive the overall search experience as fair while still encountering limitations in the representation or retrieval of specific knowledge domains. Similar concerns about representation and bias have been identified in recent library-AI literature. ([5]; [6])

E. Research Question 4: Institutional Gaps in Addressing Algorithmic Bias

TABLE VI. INSTITUTIONAL GAPS (N = 152)

Gap	Mean	SD	Decision
Absence of institutional AI governance policy	3.56	0.78	High
Lack of bias auditing protocols for AI systems	3.42	0.82	High
Inadequate training on ethical AI	3.38	0.86	High
No user participation in AI system design	3.24	0.90	High
Limited collaboration with AI ethics experts	3.18	0.94	High
Insufficient funding for ethical AI initiatives	3.45	0.80	High
Overall Mean	3.37	0.82	High

The findings reveal substantial institutional gaps in addressing algorithmic bias at Ramat Library. The highest-rated gap was the absence of an institutional AI governance policy ($\bar{X} = 3.56$, $SD = 0.78$), followed by insufficient funding for ethical AI initiatives ($\bar{X} = 3.45$, $SD = 0.80$) and a lack of bias-auditing protocols ($\bar{X} = 3.42$, $SD = 0.82$). These findings are consistent with broader evidence that funding, infrastructure, skills, and governance remain important barriers to responsible AI adoption in academic libraries. ([4]; [6])

F. Hypothesis Testing

Hypothesis 1: There is no significant relationship between AI-driven service implementation and awareness of algorithmic bias among library professionals.

Pearson's product-moment correlation analysis revealed a statistically significant positive relationship between AI-driven service implementation and awareness of algorithmic bias among library professionals ($r = 0.387$, $p < 0.001$). The null hypothesis was therefore rejected. This association indicates that higher AI implementation scores were accompanied by higher awareness scores in this sample; because the analysis is correlational, it should not be interpreted as evidence that AI implementation causes greater awareness.

Hypothesis 2: There is no significant difference in algorithmic bias perception between male and female library users.

An independent samples t-test revealed no statistically significant difference in bias perception between male and female users ($t = 1.24$, $p = 0.216$). Both male and female users expressed similar concerns about the representation of local knowledge and multilingual materials in AI-powered search results.

V. DISCUSSION

A. AI Implementation at Ramat Library

The finding that AI-driven service implementation at Ramat Library was moderate ($\bar{X} = 2.62$) is broadly consistent with recent literature showing that academic libraries are adopting AI across selected functions while continuing to face funding, infrastructure, skills, and governance constraints. [4] The concentration of implementation in plagiarism detection, catalogue search, and automated cataloguing suggests an incremental pattern of adoption rather than comprehensive integration across library services.

The moderate implementation level also provides an opportunity to incorporate fairness, transparency, documentation, and human oversight as AI capabilities expand. Establishing such safeguards during system selection, procurement, configuration, and evaluation may reduce the need to address problems only after deployment.

B. Awareness and Knowledge Gaps

The moderate awareness of algorithmic bias among library professionals at Ramat Library ($\bar{X} = 2.59$) is consistent with the broader need for AI-related capacity building identified in recent LIS research. Although professionals reported

familiarity with basic bias concepts, they reported lower awareness of fairness auditing, Explainable AI, and epistemic justice. These findings support the need for continuing professional development focused on both conceptual and practical AI literacy. ([5]; [8])

The significant positive relationship between AI implementation and bias awareness ($r = 0.387$, $p < 0.001$) indicates an association between the two variables in this sample. It should not, however, be interpreted as evidence of a causal effect. The result nevertheless supports the value of integrating AI ethics and algorithmic-bias awareness into continuing professional development programmes.

C. Epistemic Exclusion and User Perceptions

The apparent tension in user perceptions, in which users viewed AI results as generally fair while also reporting weak representation of local knowledge, reflects the multidimensional nature of algorithmic fairness. Users may evaluate the overall usefulness or fairness of a search service without being able to identify specific mechanisms through which ranking, training data, collection coverage, or language representation influence results. Research on AI bias in information retrieval similarly identifies representation and transparency as important concerns. [5]

This finding is particularly relevant to Ramat Library because the institution has documented efforts to preserve Indigenous knowledge digitally. Preservation alone does not guarantee discoverability; retrieval systems must also support appropriate metadata, language representation, indexing, and search access for those materials. [10]

D. Institutional Gaps and the Imperative for Local Frameworks

The high level of institutional gaps identified ($\bar{X} = 3.37$) indicates a need for clearer governance arrangements at Ramat Library. The absence of an AI governance policy, bias-auditing protocols, adequate training, and user participation mechanisms points to organisational as well as technical requirements for responsible AI adoption. Recent African academic-library research similarly emphasises locally relevant governance, staff capacity, and participatory approaches. [6]

The South African experience provides a relevant comparative case. Mdhlalose (2026) proposes a locally grounded Ethical AI Integration Framework centred on epistemic justice, algorithmic transparency, data sovereignty, multilingual equity, and participatory stewardship. The present findings suggest that comparable principles could be considered in developing an approach appropriate to the Nigerian context, while recognising that frameworks should be adapted to local institutional conditions rather than transferred without modification.

VI. CONCLUSION

This study has examined AI algorithm fairness and bias at Ramat Library, University of Maiduguri, revealing a landscape

of both opportunity and risk. The findings demonstrate that while AI implementation remains moderate, awareness of algorithmic bias issues is developing among library professionals and users alike. However, significant gaps persist in institutional governance, technical capacity, and the representation of local and Indigenous knowledge systems in AI-powered information services.

The study concludes that AI adoption at Ramat Library should be accompanied by deliberate governance and professional-development measures that address fairness, transparency, representation, and human oversight. The findings indicate that AI implementation is moderate, awareness of basic bias concepts is developing, and important institutional gaps remain. Because the study used a cross-sectional survey design, the findings describe associations and perceptions within the study population and should not be interpreted as evidence of causal effects or as automatically generalisable to all Nigerian academic libraries.

VII. RECOMMENDATIONS

Based on the findings, the following recommendations are made:

Development of Institutional AI Governance Policy: Ramat Library, in collaboration with the University of Maiduguri's ICT Directorate and the Department of Library and Information Science, should develop a comprehensive AI governance policy that explicitly addresses algorithmic fairness, bias auditing, and ethical AI use.

Establishment of AI Bias Auditing Protocols: The library should implement regular bias audits of all AI-powered information systems, examining search algorithms, recommendation engines, and cataloguing tools for representational biases across languages, disciplines, and knowledge systems.

Capacity Building for Library Professionals: Structured training programmes on AI ethics, fairness auditing, Explainable AI, and epistemic justice should be integrated into the library's continuing professional development curriculum.

Participatory AI Governance: The library should establish a standing AI Ethics Committee that includes librarians, users, ICT specialists, and community representatives to provide oversight and guidance on AI system design, procurement, and deployment.

Indigenous Knowledge Representation in AI Systems: AI-powered search and retrieval systems should be specifically designed or configured to adequately represent and retrieve Indigenous knowledge materials, including those in local languages such as Kanuri, Hausa, and Arabic.

Multilingual Equity in AI Services: AI systems should be evaluated for their capacity to retrieve and present materials in multiple languages, with specific attention to the linguistic diversity of northeastern Nigeria.

Collaboration with AI Ethics Researchers: Ramat Library should establish research partnerships with LIS departments and AI ethics scholars to conduct ongoing action research on algorithmic bias and fairness in library contexts.

Advocacy for National AI Policy for Libraries: Professional bodies and relevant stakeholders should support the development of national guidance for responsible AI use in academic libraries, with attention to fairness, transparency, data governance, multilingual access, user participation, and professional accountability.

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