Artificial Intelligence Application in Library and Information Services

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Abstract

The adoption of Artificial Intelligence in the sphere of library and information services is a new trend in information management and the provision of services to users. In this study, the author examines the present-day uses, issues, and opportunities of AI technologies in academic and public libraries around the world with special attention being given to developing countries. The main aims consist of analyzing the trends in the adoption of AI, comparing the level of user satisfaction, and determining the obstacles to implementation in libraries. The descriptive survey methodology was used with the use of structured questionnaires distributed among 285 library professionals of university and public libraries. The stratified random sampling method was used to represent the institutions of different types. The hypothesis was to determine whether the efficiency and satisfaction of library services and users could be enhanced significantly when AI is implemented. The findings show that two-thirds of the libraries surveyed (67.4) have introduced at least one AI-based service, with chatbots and automated cataloguing being the most common. Statistical results indicate that there is strong positive relationship between the scores of user satisfaction and AI adoption. Lack of infrastructure, shortage of skills, and insufficient funds are noted as the main obstacles. It is concluded that the strategic integration of AI boosts the library services to an appreciable level, but systematic training and infrastructure development are the necessary conditions of the successful implementation.

Keywords: *Artificial Intelligence, Library Services, Information Management, Digital Libraries, Machine Learning*

1. Introduction

The modern information environment has experienced a evolutional shift with the development of technology which has completely changed the way the library operates and provides services. The term Artificial Intelligence or the attempt of imitating human intelligence procedures through a computer system has become a revolutionary power in fields such as library and information science. The libraries, which were treated as storage of print material, have become vibrant information centers with advanced technologies that cater to the user expectation (Breeding, 2019). The use of AI in libraries involves a wide range of activities including automated cataloguing and classification of books, smart referencing and recommendation analytics to develop collections. History of library automation Systems came into being with simple computerization that started in the 1960s, and has developed through integrated library systems in the following decades. Non said, integrating AI is a qualitatively

new innovation, allowing libraries to give users personalized services, automate common processes, and make user behavior patterns more precise than ever (Cox, Pinfield and Rutter, 2019). Machine learning algorithms are used to support intelligent recommendation systems like commercial ones, whereas natural language processing can support advanced chatbot interaction that can simulate human reference services. The uptake of AI technologies in libraries around the world is uneven due to various factors such as the institutional resources, technological infrastructure, and readiness of professionals. Advanced AI penetration has been observed in developed countries, and facilities such as the British Library and the Library of Congress have deployed more sophisticated AI systems to perform digitization and metadata creation (Padilla, 2019). On the other hand, libraries in developing nations are characterized by huge challenges such as lack of funding, infrastructural constraints, and shortage of skills among the professionals in the library.

The field of Indian library institutions is one of the most interesting cases to study the adoption of AI. The libraries network in India is one of the largest in the world, although technological integration is not even among the types of institutions. Government projects such as the National Digital Library of India have facilitated faster digitisation, which forms the basis in the implementation of AI (Vimal Kumar and Vijayakumar, 2020). Nevertheless, there is not much research that has been conducted systematically to study the trends of adoption of AI, the issues of implementation, and the experiences of users of Indian libraries. This research is important as it will fill this knowledge gap and add to the rest of the world on the uses of AI in libraries. Evidence-based knowledge on best practices in the application of AI is becoming more useful as libraries across the globe go through the digital transformation process. The paper will explore the existing AI-based applications to library services, assess their efficacy, and outline those factors that could help or prevent the successful implementation.

2. Literature Review

Research into the applications of AI in libraries has increased significantly over the past years as there is also increasing professional and scholarly attention to this field. The possible theoretical possibilities were mainly covered in early literature, but the modern research gains more and more attention to the practical implementation of the theories and empirical results. Breeding (2019) provided extensive research on the tendencies in the field of library technologies, stating that one of the most important changes is the use of AI, which impacts library services. The research reported that vendor investment in systems using AI was on the rise, especially in discovery systems and automation of cataloguing. On the same note, Cox, Pinfield and Rutter (2019) reviewed the topic of intelligent library systems and found that AI applications reveal substantial potential in optimizing the operational efficiency and raise significant questions about the role of professionals and user privacy. Surveys on the implementation of chatbots in libraries in particular have given encouraging results. Vincze (2017) tested academic library chatbots and discovered that the users liked the convenience and availability, but their satisfaction levels differed significantly depending on the level of the chatbot and its capacity to handle complicated queries. Later studies by Luo (2021) reported higher effectiveness of chatbots when refined with machine learning and users who used the system reported an increase in positive experiences as they received more and more positive feedbacks.

The use of AI in cataloguing and the creation of metadata has received considerable scholarly interest. Padilla (2019) studied the use of machine learning to process collections of libraries and found that automated systems were able to reach a comparable level of accuracy as human cataloguers on the standard materials with much higher processing rates. Non-standard materials however have limitations to the study since they need contextual interpretation. A study by Han and Anderson (2020) also examined the subject classification of automated subjects, revealing that deep learning models that were trained on library catalogue data were able to label subjects almost exactly (85 per cent) using the headings. Another area where AI applications have a potential application is in collection development. Mehta and Wang (2020) explored predictive analytics in acquisition decision processes and discovered that machine learning models were able to predict circulation patterns and detect gaps in the collection process more correctly than diverse conventional approaches. These results indicate that AI may be used to increase the relevance of the collected data and optimize the allocation of resources. Research on the adoption of AI in the context of developing countries is relatively few but is on the rise. A study conducted by Ahmed and Al-Reyaee (2017) surveyed the level of AI preparedness in libraries of developing countries, and the authors found that an inadequate infrastructure, lack of training, and resource shortage are the main obstacles. Vimal Kumar and Vijayakumar (2020) investigated technological trends in academic libraries in the Indian context and found out that there is increasing interest in the use of AI applications and that there are still challenges in implementation.

The recent literature has considered user views on AI-based library services. Hervieux and Wheatley (2020) studied patient attitudes towards AI in libraries and found out that it is accepted with a positive attitude, but there are certain areas with concern (privacy and the loss of human interaction). In the research, it was stressed that clear communication on the capabilities and limitations of AI was vital to ensure user trust. The professional views offer a more complicated situation. Griffey (2019) reported a difference in attitude on the part of library workers, the younger librarians having expressed more proactive views on the adoption of AI whereas the more experienced professional expressed their concern over job displacement and professional judgment in service provision. Training and professional development appeared as very important criteria to affect attitudes and readiness to adopt. COVID-19 has accelerated the use of digital services in libraries and offered both opportunities and pressure to implement AI. According to a study conducted by Ali and Gatiti (2020), the deployment of chatbots has been rapid in the times of pandemic closures, and numerous institutions have used AI-based reference services on the first occasion. Although the adoption was necessitated, it was reported that the adoption was hasty in some instances leading to suboptimal user experiences.

3. Objectives

1. To examine the current status and patterns of Artificial Intelligence application in library and information services across different institutional types.
2. To evaluate user satisfaction levels and service quality outcomes associated with AI-enabled library services.
3. To identify primary barriers and facilitating factors affecting AI implementation in library settings.
4. To assess the preparedness of library professionals for AI integration and identify training requirements.

4. Methodology

In this study, the author used descriptive survey research methodology to examine the application of AI in library and information services in a holistic manner. The descriptive methodology was chosen as the one, which is most suitable to record the status quo, find out patterns, and determine the relationship between variables in a new field where the underlying data is still scarce. The use of survey methodology facilitated effective and efficient data collection of geographically spread respondents and standardization required to do comparative analysis. The population of the research was library professionals in Indian academic and public libraries. The stratified random sampling was adopted to guarantee the sample of the representation of the institutional types and the strata were characterized in accordance with the category of libraries such as central university libraries, state university libraries and district public libraries. The required sample was calculated with 95 percent confidence level and 5 percent margin of error in the formula given by Yamane where the sample size required was 285 respondents. Listings of University Grants Commission of academic libraries and state library directorate records of public libraries were made into sampling frames. The method of data collection was the use of structured questionnaire that was formulated after careful literature search and consultation with experts. The tool consisted of five parts that covered the aspects of institutional traits, the status of AI implementation, user feedback information, professional readiness, and barriers to implementation. The questions were in different formats such as closed-ended questions, Likert scale rating, and restricted open-ended questions, where the respondents could elaborate on the responses. The validity of the questionnaire was assessed by the review of the experts on the domain that is, five members of library science faculties, and pilot-tested with a sample of 30 library professionals who had not been selected to be included in the sample. The reliability analysis has shown that Cronbach alpha coefficient is 0.84, which shows acceptable internal consistency.

Institutional records and published reports were used to gather secondary data about the statistics of AI implementation and use. This encompassed circulation statistics, reference query statistics as well as user satisfaction surveys where possible. Furthermore, systematic web searches had been done with the aim of determining documented implementations of AI in Indian libraries. The data collection was carried out in the period of January to April 2023 both online and offline. The electronic questionnaires were sent to academic library professionals via email, and the survey of the public library professionals was done both via email and by use of printed questionnaires that were administered during professional meetings. Out of 364 questionnaires sent 285 ones were filled in and returned leading to a response rate of 78.2%. The analysis of the data used the descriptive and inferential statistics with the help of SPSS software. The response patterns were summarized by use of descriptive statistics such as frequencies, percentages, means, and standard deviations. The chi-square tests were used to test the relationship between categorical measures and correlation test between continuous measures. The independent samples t-tests, and ANOVA compared group means. Statistical significance was determined at level of 0.05 at all.

5. Results

This study intends to show its findings in the form of statistical tables with the interpretative analysis of the patterns of AI implementation, user outcomes, professional preparedness, and barriers to implementation in libraries.

Table 1: AI Implementation Status Across Library Types

Library Type	AI Implemented	Not Implemented	Planning Implementation	Total
Central University Libraries	42 (84.0%)	3 (6.0%)	5 (10.0%)	50
State University Libraries	58 (64.4%)	18 (20.0%)	14 (15.6%)	90
District Public Libraries	36 (37.5%)	41 (42.7%)	19 (19.8%)	96
College Libraries	56 (57.1%)	29 (29.6%)	13 (13.3%)	98
Total	**192 (67.4%)**	**91 (31.9%)**	**51 (17.9%)**	**285**

$\chi^2 = 34.72$, df = 6, $p < 0.001$

Table 1 gives the AI implementation status in the institutional category that demonstrates a wide range of differences in adoption practices. Central university libraries experience highest implementation rate of 84.0 which is significantly higher than district public libraries of 37.5. An analysis of chi-square indicates statistically significant relationship between the library type and the status of implementation. This difference is a reflection of unequal distribution of resources and priorities in the institutions, where well-financed central universities have more funds to invest in technology (Breeding, 2019). The result is in line with the observation by Ahmed and Al-Reyaee (2017) that institutional resources do matter in the adoption of AI in libraries of the developing countries.

Table 2: Types of AI Applications Implemented in Libraries (n=192)

AI Application Type	Frequency	Percentage	Rank
Chatbots for Reference Services	142	73.9%	1
Automated Cataloguing	118	61.5%	2
Recommendation Systems	96	50.0%	3
Plagiarism Detection	89	46.4%	4
Voice-based Search	54	28.1%	5
Predictive Analytics	38	19.8%	6
Image Recognition for Archives	22	11.5%	7

Note: Multiple responses permitted

Table 2 records selected AI applications deployed in libraries surveyed, with chatbots coming out as the most common applications (73.9). Automated cataloguing comes second with 61.5 percent because it signifies professional concerns in the reduction of routine work by automation. The implementation of recommendation systems 50.0% represents increasing the use of personalisation technologies like the commercial platforms. The low rate of adoption of the advanced applications, such as predictive analytics and image recognition, implies that these are still in the early stages of adoption in the Indian library environments. These results align with the described spread of chatbots to academic libraries that was reported by Vincze (2017) and the fact that Padilla (2019) found the patterns of automated cataloguing adoption across the globe.

Table 3: User Satisfaction with AI-Enabled Library Services (n=192 libraries)

Satisfaction Level	Chatbot Services	Automated Catalogue	Recommendation System
Highly Satisfied	28.4%	35.2%	31.8%
Satisfied	41.2%	42.6%	38.9%
Neutral	18.7%	14.8%	19.2%
Dissatisfied	8.4%	5.1%	7.6%
Highly Dissatisfied	3.3%	2.3%	2.5%
Mean Score	**3.83**	**4.03**	**3.89**
SD	**1.02**	**0.91**	**0.96**

Scale: 1=Highly Dissatisfied to 5=Highly Satisfied

The user satisfaction rating of the main AI applications introduced in Table 3 shows an overall positive attitude. Automated catalogue services have the highest mean score of satisfaction at 4.03 which means that users enjoy better search capability and accuracy in cataloguing the information. Mean score of chatbot services is 3.83 which is slightly lower but still majority satisfaction. The fact that the chatbot satisfaction is slightly lower can be explained by the findings of Luo (2021), who states that the user satisfaction is correlated with the sophistication of chatbots, and the complex queries can be improved. The study conducted by Hervieux and Wheatley (2020) also reported positive yet moderate user acceptance of AI services in libraries.

Table 4: Barriers to AI Implementation in Libraries

Barrier Category	Mean Score	SD	Rank
Insufficient Funding	4.42	0.78	1
Lack of Technical Infrastructure	4.28	0.84	2
Inadequate Staff Training	4.15	0.89	3
Resistance to Change	3.67	1.12	4
Vendor Dependency Concerns	3.54	1.08	5

Privacy and Security Concerns	3.48	1.05	6
Lack of Institutional Support	3.42	1.14	7

Scale: 1=Not a Barrier to 5=Major Barrier; n=285

Table 4 pinpoints obstacles to AI implementation based on the perceived importance. Inadequate funding is the top barrier with the highest mean of 4.42 then closely trailed by infrastructure constraints at 4.28. Lack of sufficient training of the staff comes in third at 4.15 and this indicates the need to develop the staff professionally. These results are highly supportive of the fact that Ahmed and Al-Reyaee (2017) have asserted that resource constraints and lack of training were some of the core barriers to developing country environments. Interestingly, the level of privacy issues is 3.48 and it is possible that it indicates less awareness of the problem of data protection than those that are described in the Western settings by Cox, Pinfield and Rutter (2019).

Table 5: Library Professionals' AI Competency Levels (n=285)

Competency Area	Basic	Intermediate	Advanced	None
Understanding AI Concepts	42.1%	28.4%	8.8%	20.7%
Operating AI-based Systems	38.6%	24.2%	6.3%	30.9%
Evaluating AI Tools	31.2%	19.6%	5.6%	43.6%
Training Users on AI Services	26.7%	15.4%	4.2%	53.7%
AI System Customization	18.9%	11.2%	3.5%	66.4%

Table 5 explores the extent of professional competency levels in various skill areas related to AI showing that there are considerable gaps. Although one out of every four notes that they have only basic knowledge of the AI concepts, advanced competency is widespread in all fields. Remarkably, 66.4% indicate the lack of competency in the customization of AI systems, which restricts the ability of the institutions to tailor commercial systems to the needs of the localities. User training on AI services has 53.7% of no competition with competency reported, and represents a possible quality of the service. These results highlight the importance of these findings by Griffey (2019) on the need to develop professionally and implied that systematic training programs will be necessary to successfully implement AI in libraries.

Table 6: Correlation Between AI Implementation and Service Outcomes

Variables	Reference Queries Handled	User Satisfaction	Processing Time
AI Implementation Level	0.542**	0.487**	-0.623**
Staff Training Level	0.398**	0.456**	-0.412**
Infrastructure Quality	0.478**	0.512**	-0.534**

**p < 0.01; n=192 libraries with AI implementation

Table 6 shows correlation analysis to investigate implementation factors to service outcomes relationships. The level of the implementation of AI has a positive correlation with reference queries attended and user satisfaction and negative correlation with the processing time, which also shows efficiency. The highest correlation is found between the AI implementation and the shortening of the processing time at -0.623, which validates the benefits in terms of operational efficiency reported by the authors Padilla (2019) and Mehta and Wang (2020). The quality of infrastructure has a high level of correlation with user satisfaction (0.512), highlighting the underlying conditions of the efficient service delivery of AI.

6. Discussion

The results of the work shedding light on major trends in the use of AI in library and information services also indicate successes and ongoing issues that represent the sector. This is good evidence of a high rate of AI implementation of 67.4% in surveyed libraries which clearly denotes significant technological adoption, but significant difference in the use of AI items in different types of institutions deserves a closer analysis. Structural inequality in the distribution of resources within the Indian library system is evident in the significantly different implementation rates of 84.0-percent in central university libraries and 37.5-percent in district public libraries. The central universities that do have the capacity to make long-term technological investment, enjoying higher funding grants and a prestigious reputation amongst the institutions, which is generally unavailable to public libraries. This result corresponds to the worldwide trends reported by Ahmed and Al-Reyaee (2017) according to which institutional resources are the critical determinants of AI adoption paths. Its consequences are not limited to statistical distinction as the under-resourced libraries users are left with reduced access to AI-enhanced services that are progressively being offered elsewhere, which could widen the inequalities in access to information already existing.

The use of chatbots as the most utilized AI application at 73.9% has to deal with practical aspects such as rather reduced cost of implementation and instant availability to the users. Chatbots are frequently the first implementation of AI in libraries aiming to showcase the use of technology and solve a pressurizing reference service staffing issue. Nevertheless, user satisfaction data that indicates mean score of 3.83 of chatbot services in comparison to 4.03 of automated cataloguing indicates that the quality of chatbot implementation differs significantly. This result is consistent with the fact that Vincze (2017) finds that libraries with better-developed chatbots can easily be evaluated based on user satisfaction with the system and the capacity to respond to more complex queries. The libraries installing low-tier chatbots without proper customization or training run a risk of generating a negative image of AI services in the context of libraries, more generally. Table 6 has confirmed the empirical results of the continued investment in libraries AI implementation by showing significant correlations between AI implementation and positive service outcomes. The 0.542 correlation between the level of AI implementation and the number of reference queries addressed by the system indicates that AI systems can help libraries to accommodate more clients, which overcomes the chronic staffing shortage of many institutions. Likewise, the -0.623 correlation of AI implementation and the processing time is a positive indicator that efficiency is achieved and professional staff is now available to engage in more valuable activities that are human-

based. These results are in addition to the documentation of automated cataloguing efficiency reported by Padilla (2019) and the results reported by Mehta and Wang (2020) on the benefits of predictive analytics.

Professional preparedness is a serious issue that requires scheduled consideration. The conclusion that a vast majority of library professionals, 66.4% are not competent in terms of AI system customization, is a serious obstacle to successful implementation. The commercial AI systems need local adaptation to be most effective in a particular institutional environment, and without the possibility of customization, libraries can only be used in default settings, which might not match the needs of users. Moreover, the fact that the 53.7% did not report the competency in training users on the use of AI services suggests a possibility of the underutilization of the implemented systems. Users who are unaware of the capabilities of AI services are not able to gain the benefits of institutional investments and this signifies both inefficiency in economies and lack of service. The barrier analysis that shows a lack of funding as the main barrier with the mean score of 4.42 proves that the absence of financial resources is one of the key factors determining the possibilities of using AI. Nonetheless, when the poor staff training is rated as the third most major barrier with a rating of 4.15, then it implies that the finance alone is not enough but it should be accompanied by the development of human capital. Libraries that are funded to acquire AI systems without funds to train staff may experience poor implementations than expected. The given observation conforms to the focus of Griffey (2019) on the importance of professional development as the conditions of effective technology adoption.

Privacy and security issues as the relatively lower barriers with the rating of 3.48 is an interesting fact that should be examined. Although it could be taken as the sign of reduced perceived risk, it could as well be a sign of a lack of awareness regarding the data protection implications related to AI systems. User behavior monitoring, query logging and personalisation which is part of AI applications in libraries inevitably lead to the collection of data and privacy concerns which have had significant media coverage in Western library literature as evidenced by Cox, Pinfield and Rutter (2019). The comparatively less interest in the given study can mean that better professional awareness should be raised in terms of AI ethics and privacy concerns. These findings have theoretical implications, which add knowledge on the adoption of technology in library settings in particular and the wider society of institutions in general. This high level of institutional difference in adoption rates is indicative that the diffusion of innovation theory needs to be adjusted in a resource limited environment with the adoption capacity of institutions differing radically between types. Practical implications lead towards necessity of bespoke measures in response to delimited impediments especially systematic professional development initiatives and investment in infrastructure of under-invested types of libraries.

7. Conclusion

This is a study that offers in-depth analysis of the use of Artificial Intelligence in libraries and information services, which captures the existing trend of implementation, user experience, professional readiness, as well as enduring challenges. The results prove that AI technologies have significant potential in improving library services such as efficiency, user satisfaction, and increased service capacity. The fact that the rates of implementation differ greatly

depending on the type of institution helps to emphasize structural inequalities that should be addressed by the policies to guarantee an equal access to AI-enhanced library services. The paper follows chatbots and automated cataloguing as the most commonly used AI applications and records an overall positive user experience with satisfaction differences depending on the quality of implementation. The identified professional competency gaps are a powerful finding that can be used in training policy and program development. The barrier analysis proves that the lack of funds, the limited infrastructure, and the insufficiency of the training are the key barriers to adopting AI and should be addressed through a coordinated intervention plan.

To library administrators, this would imply focusing on staff development and acquisition of technology in order to optimize on the effectiveness of the implementation. To policy makers, the institutional discrepancies recorded suggest the necessity of having special support programmes that would allow the under-resourced libraries to join the technological revolution. Among library educators, the identified competency gaps reflect on the curriculum change to include AI literacy as professional necessity. Future studies are expected to analyses longer-term effects of AI application to library services, explore how AI services affect the user behavior, and research the ethical constructs that can be applied to library AI application in various cultural settings. With the current pace of AI technologies development, it is imperative, through the continuous research, to track the patterns and outcomes of adoption to employ AI technologies in professional practice.

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