

Harnessing AI in the library of IITs: A Journey Towards Automation to Intelligence

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Abstract

This study carries out an in-depth analysis of the impact and execution of Artificial Intelligence (AI) technologies in one of the noteworthy libraries in the twenty-three (23) Indian Institutes of Technology (IITs). It would be pertinent to mention that there is hardly any doubt that one of the most radiating technologies in the field of computing technologies is Artificial Intelligence which in turn is rendering a profound impact on the functioning of the libraries in the IITs. One of the main goals and objectives of the evaluation is the connection of AI tools in their effective usage, gauging their benefits and limitations, thereby appraising their repercussion on the service delivery and user satisfaction, apart from comprehending the willingness of the staff towards the integration of Artificial Intelligence (AI). A survey method was utilized by distributing a structured questionnaire to all the 23 IIT libraries. Around 15 responses were received from the libraries in IIT. The data collected was analyzed in MS Excel and Jamovi through descriptive statistics, one-way ANOVA, and an F-test. The observations disclose that 73.30% (n=11) of IIT libraries have used integrated AI tools. It contains plagiarism detection (72.70%), chatbots (63.60%), and AI-based discovery services (54.50%), which are being extensively instigated. The usage of AI is elevated in reference services (90.90%) and acquisition (81.80%). A perception analysis utilizing ANOVA ($F=0.015$, $p=0.9975$) indicates that there is hardly any significant variance in the views of the librarians within service quality measurements, representing equally positive views. The data privacy concerns (62.50%), technical issues (55%), and a lack of skilled staff (45%) were considered significant challenges. There is a limitation in the scale of training as of date with only 33.33% of libraries supporting extensive-scale AI training. The study states that IIT libraries perform well in AI. However, it also requires an improvement in skills, infrastructure, and policies.

Keywords: Academic libraries, artificial intelligence (AI), ICT in libraries, IITs, library automation

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INTRODUCTION

Artificial Intelligence (AI) is considered a technological improvement that effectively facilitates technology to replicate human intelligence by learning, processing, and autonomous functioning [1]. This kind of technological innovation is widely adopted in disciplines like finance, banking, healthcare, education, and libraries to increase operational efficiency, perform data analysis, and boost user satisfaction [2]. The AI advances efficiency, precision, and customization while functioning on a 24/7 basis. This permits institutions to save time, minimize errors, and provide better support and services [3]. In libraries, the implementation of AI technology and tools further enhances user satisfaction, streamlines repetitive tasks, and boosts retrieval accuracy for the many individuals who

utilize these systems. Thoroughly, AI tools in libraries include advanced search tools, web-based reference support, collection building tools, and user interaction analysis systems [4, 5].

Indian Institutes of Technology (IITs) are considered eminent and premier institutions in the country. They have ample financial support and infrastructure, thereby facilitating an ideal environment for the study of AI implementation in libraries. Despite enormous universal research on AI in libraries, there has been no efficient experimental research conducted which has evaluated its performance within the ecosystem of IITs thereby laying a strong emphasis on an uncharted area. The study investigates IITs and their innovative research which formulates them as a paradigm example for exploring AI analysis in higher academic libraries. It further investigates AI integration in the libraries of IITs, identifying existing practices and areas for expansion.

Objectives of the Study

The objectives of this study are as follows:

- To identify the AI technologies employed in the libraries of IITs and their domains of implementation.
- To investigate the benefits, constraints, and staff willingness for AI implementation.
- To evaluate the impact of AI on patron satisfaction and service delivery.
- To determine the anticipated future implications and planned responsibilities of AI in IIT libraries.

Scope of the Study

This study is entirely concentrated on the application of Artificial Intelligence (AI) in the libraries of 23 Indian Institutes of Technology (IITs). It also examines the AI tools and technologies that are effectively used for managing library collections, services, and other appropriate aspects. Considering that this technology is exorbitantly expensive and requires technological infrastructure and technical skills, the study concentrates on technological institutions with adequate funding. Therefore, IITs were selected for this study. This study affords a fundamental concept for other academic institutions to implement AI in their libraries.

Limitations of the Study

This study is confined only to IIT libraries. The concentration exclusively on IITs omit a broader aspect of other Indian academic libraries, which may impede the customary scope of the conclusions. It also prioritizes technological aspects, with insignificant emphasis on the user perspective, financial implications, or regulatory concerns. There are evident recent AI developments that may be skipped due to their swift adaptations.

LITERATURE REVIEW

The implementation of Artificial Intelligence (AI) in libraries is a massive advantage that libraries can trust without any doubt. Research is gradually observing that it is possible to boost services, manage systems, and increase patron involvement. This not only confirms the opportunities offered by AI as well as the limitations of its practical implementation in libraries.

Development of AI Research in Library Science

Bibliometric research has also unraveled that the volume of AI research in library science has substantially increased during the past five years. This research has already laid a strong emphasis on the areas of automated services, data management, and AI-based content access. Vasishta, Dhingra, and Vasishta consider this development as a major trend, acknowledging the shared intellectual attention to AI-powered inventions [6], while Concha, Zenteno, and Alfaro concluded that AI is not only a practice rather the main device in planning decisions through the analysis of several cases across the globe [7].

AI For Service Delivery and User Engagement

The literature emphasizes the theme of AI applications in enhancing service delivery and user experience. Mali and Deshmukh and Das and Islam convey the notion that AI and machine learning

algorithms significantly contribute to the automation of book organizing, flow of cataloging, and the generation of user-specific recommendations [8, 9]. Paul and Chauhan also argue that AI is the most essential technology in the development of assistive devices that remove barriers to access for people with infirmities [10]. In this context, Shakeel Ahmed et al. and Ajakaye also referred to as AI-powered technologies and enablers of academic networking, user-oriented content, and operational capability, which ultimately revitalizes the library as a knowledge center [11, 12].

Strategic Adoption and Institutional Readiness

While the AI holds significant capability benefits, effective utilization depends on its alignment with the institutional objectives of technological advancements. Harisanty et al. emphasized that the widespread application of AI is not a transient trend and called for a critical examination of the implications of AI on a long-term significance [13]. Malakar et al. attempted to discuss how Indian academic libraries are incorporating AI in a deliberate manner and tried to link the implementation with broader policy and infrastructure contexts [14]. Similarly, Mwantimwa, and Msoffe demonstrated the capacity of proactive AI to transform service delivery yet emphasized the role of planning and capacity building [15].

Regional and Contextual Variations

The potential decision to use AI transforms significantly from one region to another and is basically affected by the infrastructure and the types of governance. It, therefore, follows that the works of Santosa and Xu and Loo would be relevant in this respect, since they observed that the present configurations of library adoption in Southeast Asia are categorized through the methods local institutions are funded, the government's priorities, and how digitally ready the libraries are [16, 17]. On the other hand, Williamson, and Fernandez reported how AI-based academic search resources are gradually accepted into academic Western libraries along with the infrastructural developments [18].

Ethical and Moral Considerations

Apart from the apprehensions about regional variations, the figure of morality is featured prominently in AI library-related themes in the collected literature. Bubinger and Dinneen envisioned the functioning of concrete frameworks that not only protect privacy yet also practice fairness and hold organizations accountable as the central point of concern [19]. Similarly, Hasan, Saifullah, and Hashmi discussed numerous concerns, such as, confidentiality of data, the possibility of work-related disruptions, and the risk of reduced integrity [20]. Bagchi further heightened the scope from data to metadata, casting a cautionary note on the development of generative AI-based metadata without the specification of ethical principles, even in the environment [21].

Challenges and Constraints

However, these technologies comprise their challenges, and the advantages of AI clearly outweigh these. It is a limit on the potential applications of AI in libraries. It further includes economic expenses, insufficient professional knowledge, data privacy liabilities, and struggle to change [13, 20]. Shakeel Ahmed et al. cited that the encounters are researched greater for developing nations, where intellectual environments are often hampered by constrained expertise and insufficient infrastructural resources [12]. The adoption of these kinds of such challenges requires persistent economic venture pointed at capability developing, moral neighborhood of policies, and encouraged institutional collaboration. AI technologies in libraries enhance competence, personalization, accessibility, user experience, and overall efficiency [22]. Although it has a plethora of huge potentials. AI in libraries confront the following obstacles:

- High costs,
- Limited professional expertise,
- Data integrity issues, and
- Concerns about data privacy.

The existing research demonstrates that AI can abundantly enhance library services to its users. It does not entirely justify how libraries can execute these technologies in substantial environs. However, the maximum research emphasizes universal tendencies, AI tools, and conceptual advantages. There are very few studies that analyze the reasonable willingness, expertise, infrastructure, and policies required for valuable AI implementation in academic libraries. There are certain moral issues, such as, privacy, and accountability that need to be kept in view and considered. The literature does not display how institutions refer to these apprehensions during implementation. A study from progressive countries remains restricted and generally emphasizes challenges rather than resolutions. Predominantly, there are no systematic experimental studies on AI implementation in IIT libraries. Even though IITs are technically enhanced and financially sustainable, it establishes a clear gap in recognizing the real scope, challenges, and institutional awareness for the usage of AI in leading Indian academic libraries.

METHODOLOGY

The study used a survey research method to examine the AI tools and their applications in the libraries of Indian Institutes of Technology (IITs). It facilitates competence and comparable data collection among institutions functioning within related academic and structural ecosystems. A census approach was assumed by aiming at all 23 IIT libraries. 15 institutions responded and leading to a 65.21% response rate. These responses created the final dataset for analysis. A structured questionnaire was designed in Google Forms. It contained various fragments wrapping institutional information like AI tools adopted, areas of application, staff enthusiasm, challenges, and stated advantages. The questionnaire was formulated on the basis of an encompassing review of existent literature, and expert validation was embarked on to ensure conceptual clarity, significance, and subject authority. Nominal, ordinal, and five-point Likert scales were used for data analysis to obtain procedures and assessments thoroughly. The questionnaire was shared via email and WhatsApp messages. Subsequently, follow-up reminders were sent frequently to enhance involvement. The collected responses were exported to Microsoft Excel and Jamovi for data cleaning, organizing, and analysis. Excel was used for data cleaning and descriptive summaries. However, Jamovi was used for the advanced statistical tests [23]. The descriptive statistics summarized AI implementation tendencies while the One-way ANOVA and F-tests were used for identifying variances in interpretations related to user-experience, service quality, resource usage, and professional participation [24]. This approach established accuracy, reliability, and a deep understanding of AI applications among the libraries of IIT.

DATA ANALYSIS AND FINDINGS

This segment portrays the analysis of data and significant conclusions from the study, which focuses on significant perceptions and findings.

AI Technology Adoption Status

This study's primary objective is to exhibit the AI tools, and the associated technology implemented in IIT libraries, along with the sections where AI is employed. The evaluation of the data (N=15) specified an incredible adaptation rate. A total of 73.30% (n=11) of IIT libraries implemented artificial intelligence in some areas. However, 26.70% (n=4) of IIT libraries have not yet implemented AI technologies as shown in Figure 1. None of the libraries studied the implied future implementation or proposed a demand for assistance or resources.

In Figure 2, Among the implementing libraries (n=11), AI-driven plagiarism detection was the most dominant technology at 72.70% (n=8). Chatbots/virtual assistants at 63.60% (n=7) were the second most dominant technology. AI-based discovery tools indicated moderate acceptance at 54.50% (n=6). Automated cataloging systems were implemented in 45.50% (n=5) of the libraries. There are, however, specific applications, such as, personal recommendations and facial recognition for access control, where each exhibited an implementation rate of 27.30% (n=3). A host of innovative technologies, such as, book recommenders, writing assistants, LaTeX editors, and data analysis tools signified 9.10% implementation (n=1), which are in the preliminary evaluation phase.

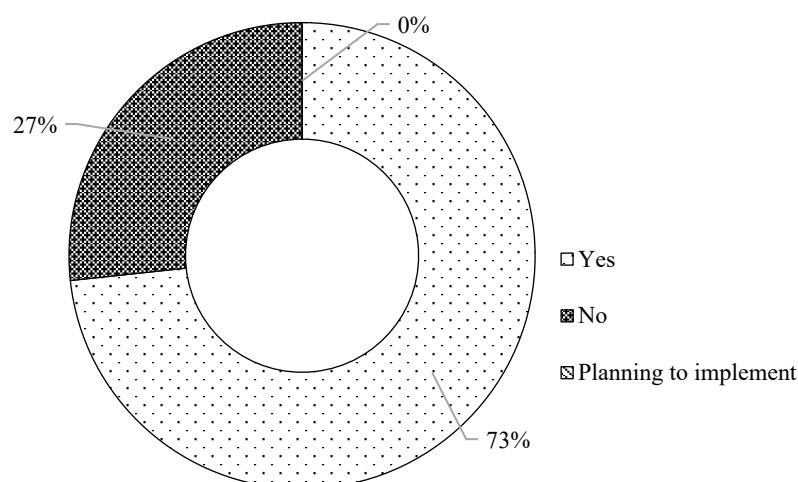


Figure 1. Implementation of artificial intelligence in libraries.

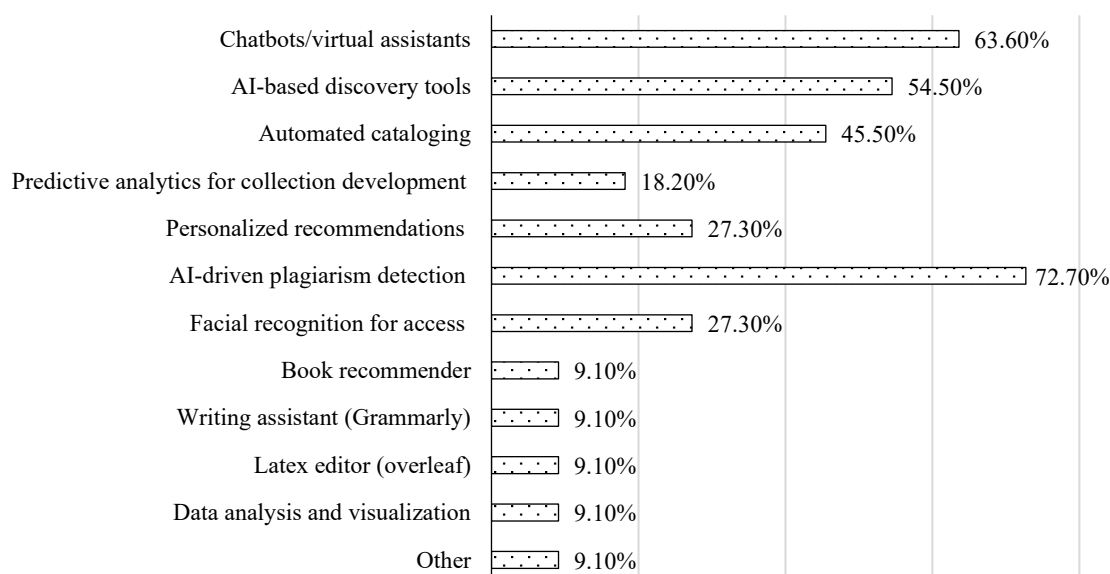


Figure 2. AI Technologies Implemented.

Functional Domain Analysis

The explicit operational areas AI has been implemented in library operations. However, in Table 1 Reference Services displayed the most significant level of AI integration at 90.90% ($n=10$, $\mu=0.91$, $\sigma=0.30$). It also displayed an extensive acceptance of AI-enabled information assistance equipment. The acquisition operations followed for 81.80% ($n=9$, $\mu=0.82$, $\sigma=0.40$), indicating the efficiency of AI application in collection development activities. The AI integration in Information Retrieval Systems showed a substantial significance at 72.70% ($n=8$, $\mu=0.73$, $\sigma=0.47$). The Circulation Management recounted AI technology in use in 63.60% of libraries ($n=7$, $\mu=0.64$, $\sigma=0.50$). The cataloging procedure displayed a moderate acceptance rate at 54.50% ($n=6$, $\mu=0.55$, $\sigma=0.52$). The user behavior analytics represented the lowest integration level of 36.40% ($n=4$, $\mu=0.36$, $\sigma=0.50$), a key area with great potential for future development.

Impact Assessment on Service Quality

The Tables 2 and 3 indicate the results of one-way ANOVA, which was conducted to establish whether there were statistically significant variances in the librarian's perception about four diverse

dimensions of AI implementation in library services, that is, enhancement of user experience, rapidity of service delivery, effectiveness in resource management, and personalization of services. Each of these dimensions was observed based on responses from 15 participants who rated their perceptions based on a five-point Likert rating scale. The evocative statistics displayed that the mean scores are closely grouped, 3.13 for both user experience and service delivery, 3.07 for resource management, and 3.00 for personalization, which reflect moderately positive and relatively consistent perceptions about the impact of AI. The variances across the groups range narrowly from 4.00 to 4.27, an indication of a high level of consistency in the distribution of responses. The ANOVA results ($F(3,56) = 0.015$, $p = 0.9975$) indicate that there are no statistically significant variations among the mean perceptions since the p-value is far above the conventional threshold level of 0.05 and the calculated F-value is far below the critical F-value of 2.769. The conclusions recommended that the librarians' perception of AI implementation has a similar level of influence across all the service areas. Such dependability implies that the approach to integrating AI into libraries may be unified and coordinated. It gives the impression that it is the approach of the libraries to adopt AI in an open-faced manner rather than just focusing on single functional areas. It is due to this, that advancements appear to take place across user services, service speed, management efficiency, and personalization. The results of the one-way ANOVA clearly depicted the responses of a stable and constant nature. This reflects a common understanding of AI in library work.

Implementation Challenges and Barriers

The Table 4 primarily evaluates the most critical barriers to AI implementation in libraries. The data privacy concerns turned out to be the most significant obstruction at a frequency of 62.5% ($\mu = 0.625$, $\sigma = 0.49$), which confirms that libraries are guardians of confidential information. Amongst the most important obstacles, technical issues occupied the second position among the most significant barriers. It was cited by 55% of the responders ($\mu = 0.55$, $\sigma = 0.50$); this indicates there is some ambiguity concerning digital infrastructure and system interoperability. A lack of qualified personnel appeared to be a significant problem and was reported by 45% of them ($\mu = 0.45$, $\sigma = 0.50$), underscoring the urgent requirement for continuous human resources development. Inadequate funding was reported in 37.5% of libraries ($\mu = 0.375$, $\sigma = 0.49$). The lack of certainty as to the expected outcome was stated in 35% of the cases ($\mu = 0.35$, $\sigma = 0.48$), reflecting the uncertainty regarding the effects expected from AI. The resistance to change appeared only in 25% of cases, $\mu = 0.25$, $\sigma = 0.44$, thus depicting quite a positive organizational attitude to the implementation of AI. A total of 7.5% of libraries have not reported any problems in implementation, which indicates that there was an effective adaptation strategy pursued at least in some IITs.

Table 1. AI Usage in library functions.

Library Function	Frequency (Yes)	Percentage	Mean	Median	Mode	Std. Dev.
Acquisition	9	81.80%	0.82	1	1	0.4
Cataloguing	6	54.50%	0.55	1	1	0.52
Reference Services	10	90.90%	0.91	1	1	0.3
Circulation	7	63.60%	0.64	1	1	0.5
User Behaviour Analytics	4	36.40%	0.36	0	0	0.5
Information Retrieval	8	72.70%	0.73	1	1	0.47
Other	2	18.20%	0.18	0	0	0.4

Table 2. Summary of perceived impacts of AI integration on the library.

Groups	Count	Sum	Average	Variance
Improvement in user experience	15	47	3.133333	4.266667
Improvement in the speed of service delivery	15	47	3.133333	4.12381
Impact on efficient resource management	15	46	3.066667	4.066667
Influence on the personalization of services	15	45	3	4

Table 3. Perceived impacts of AI Integration on the libraries.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.183333	3	0.061111	0.014853	0.9975	2.769431
Within Groups	230.4	56	4.114286			
Total	230.5833	59				

Table 4. Challenges in AI implementation in libraries

Challenge	Frequency (N)	Percentage (%)	Mean	Median	Mode	Std. Deviation
Lack of funding	15	37.5	0.375	0	0	0.49
Lack skilled staff	18	45	0.45	0	0	0.5
Data privacy concerns	25	62.5	0.625	1	1	0.49
Resistance to change	10	25	0.25	0	0	0.44
Technical issues	22	55	0.55	1	1	0.5
Uncertainty outcomes	14	35	0.35	0	0	0.48
Other	2	5	0.05	0	0	0.22
No challenges faced	3	7.5	0.075	0	0	0.27

Staff Training and Professional Development

The Figure 4, suggests that training for staff is still extremely limited, with only 33.33% (n=4) libraries offering significant training in AI. In addition, 58.33% (n=7) reported providing only partial training, suggesting consistency with more general anxieties regarding the existing gap in skills. This indicated an outstanding potential for professional development. Only 8.33% (n=1) of the libraries reported no AI training at all, which fortified the magnitude of continuing skill development.

The Table 5 also highlights the fact that the participation of the variance library professional in AI-related professional development activities is high and, therefore, requires further investigation. Further, in this regard, the F-test for equality of variances was implemented to compare proactive participation in workshops, seminars, and conferences concerning Artificial Intelligence in libraries. The average is much higher for participation in workshops, $M = 0.80$, than for conferences, $M = 0.73$. However, there was also a variance: far higher for workshops, 0.60, compared to conferences, 0.21, which, therefore, means that the range of the degree of involvement among respondents is much higher. The F-Value for this test was 2.86, larger than F-Critical = 2.48 at 0.05 significance level: $P\text{-value} = 0.0292$. It further turned out that the participation in a workshop can, therefore, adapt more for respondents, presumably due to diverse availability, institutional collaboration, or perceived relevance. The participation in conferences appears to be more consistent across respondents. The results point out the emerging

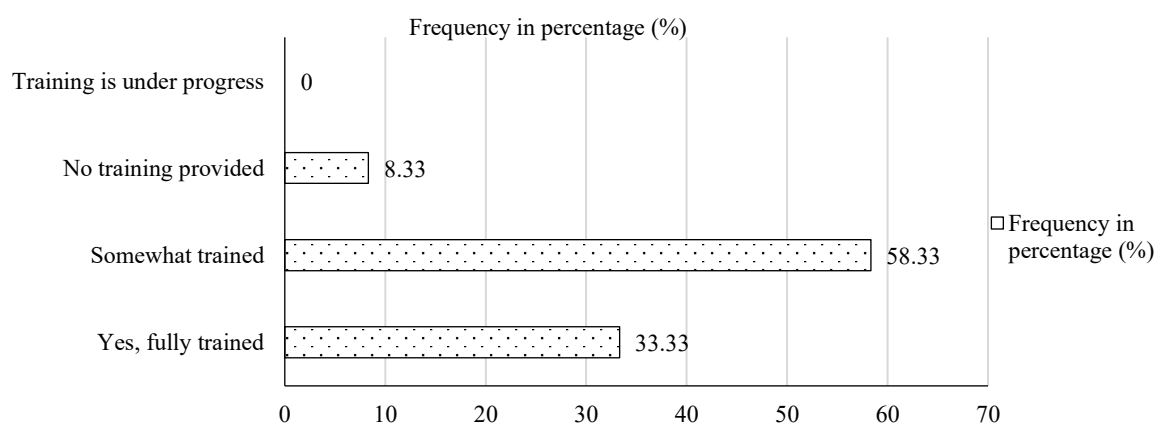


Figure 3. Staff Competency in Using AI Tools.

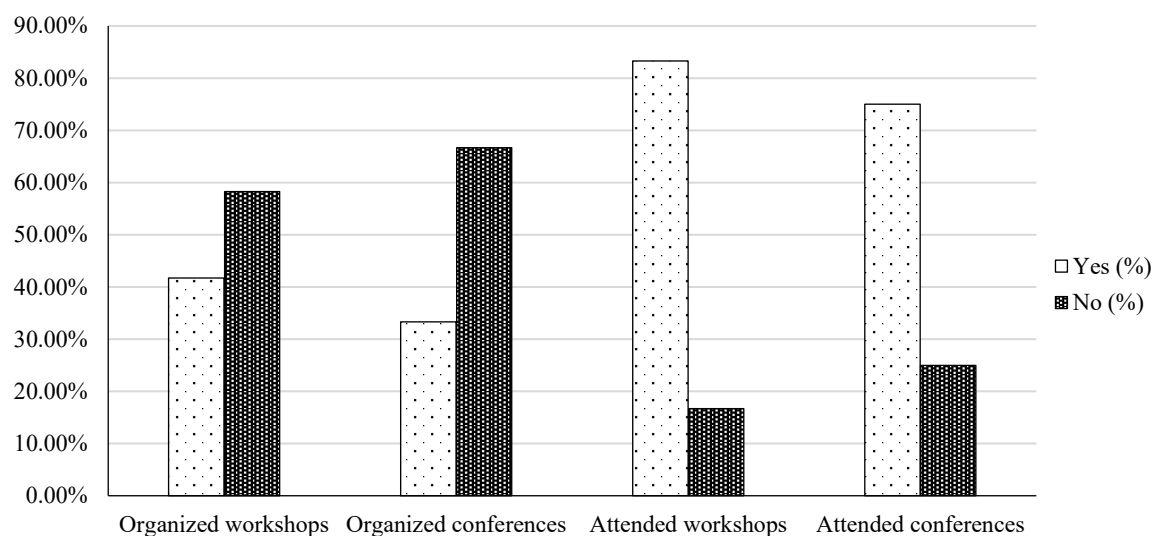


Figure 4. Library Professionals' Involvement in AI Workshops and Conferences

Table 5. Library professionals' involvement in AI workshops and conferences.

F-Test Two-Sample for Variances		
	<i>Organized or Attended Workshops Related to AI in Libraries</i>	<i>Organized or Attended Conferences Related to AI in Libraries</i>
Mean	0.8	0.733333
Variance	0.6	0.209524
Observations	15	15
Df	14	14
F	2.863636	
P(F<=f) one-tail	0.029229	
F Critical one-tail	2.483726	

requirement for more equitable access to workshops and stronger support for comprehensive professional development initiatives within the field of library science.

Future Priorities and Strategic Directions

The qualitative analysis exhibits the various priority areas which accentuated at the outset by IIT libraries. The user services and data retrieval have appeared as the prime focus areas, highlighting user-centered AI applications. IITs libraries are pursuing the implementation of progressive products, such as, book recommendation systems, advanced information retrieval tools, virtual assistants, and face recognition technologies. It indicates the implementation of more modern and stretched out AI applications. Scientometrics tools appeared as famous examples of research-related AI applications. Some of the smart discovery methodologies, automated metadata tagging, digital preservation, and space management features are examined as part of an extensive approach to AI application approaches.

DISCUSSION

The aforesaid study investigates the embracing of AI in IIT libraries. The succeeding practice concerns its influences, challenges faced, and significance for further development. It forms a worthy addition to the developing discussion on the adoption of AI in academic libraries. The conclusions of the study also shed light on the status of AI adoption initiatives within the libraries of the IITs. Approximately 73.3% of IITs' Libraries have implemented AI technologies in reference services (90.9%), acquisitions (81.8%), and plagiarism detection (72.7%). In the context of AI technology,

chatbots, discovery systems, and automatic cataloging are also in practice, showing the integration of next-generation digital tools. The respondents further responded that AI always had a positive impact on user experience, service rapidity, resource management, and personalization results that align with previous study [25]. The outcome concurs with earlier studies [13, 20], which mentioned that AI improves library efficiency and user satisfaction. There have also been some similar trends which were also unveiled in previous researches [18], in which the librarians were found to implement AI as part of an overall strategy. Still, inadequate utilization of techniques, such as, analytics of users' behavior directs to areas that still requires further development, as noted in the previous study [15]. The results of the present research show that IIT libraries are systematic and effective in integrating AI into a substantial variety of services. It further illustrates that they are radically scaling up the use of AI further, especially with improved professional development and increased infrastructure. The analysis revealed that the existing implementation frameworks explain the emergence and integration of AI in academic libraries.

Despite the total positive responses, there are countless challenges that persist and restrict the effective deployment of AI in IIT libraries. The major challenges identified were data privacy concerns from 62.5%, negligible technical setbacks from 55%, and insufficient professional expertise from 45%. While funding is not one of the key barriers; the observations insinuate the superior requirement for more training and stronger data governance frameworks. These types of explorations postulate that the availability of technologies alone is not enough; there needs to be the development of the competence of the staff and the setting up of appropriate policies [26]. Even though most of the institutions acknowledge the magnitude of training of the staff, only 33.3% of the institutions offer comprehensive training on AI. Hence, this has revealed a clear gap in the skills [27]. The significant difference in participation from AI workshops and conferences $F = 2.86$, $p = 0.0292$ points to the variance in professional development engagement. This agrees with Shakeel Ahmed et al. who insisted on uninterrupted training to reinforce the competencies of AI among librarians [12]. The findings also imply an increasing interest in advanced AI tools, such as, a book recommendation system, face recognition, scientometrics, and automated metadata tagging [28]. From this trend onwards, there is a paradigm shift from the traditional to automation towards intelligent user-centered solutions [29]. The libraries in the IITs can facilitate AI adoption for academics if they develop clear regulations and policies, collaborate, and adapt AI to Indian demands. This study only determined on the IIT libraries, and thus, the aftermath may not be generalized to all the Indian academic libraries. It predominantly situates more emphasis on institutional and functional attributes with less attention given to user opinions, costs or policy matters. It is principally due to the rapid development of emerging AI technology, that it may replenish some revolutionary AI tools. The future study should assess the long-lasting impact, solicit user feedback, and assess cost. The comparison of the various types of organizations may reveal the role of local contingencies in the use of AI.

Recommendations

The study suggests instant development of AI training since there are only 58.33% of the IIT libraries that presently allocate ample capacity-building. Institutions should also reinforce data privacy measures, a priority for 62.5% of respondents. A medium-term approach needs to be emphasized on assuming user-behavior analytics. It should mandatorily increase inter-library resource sharing over AI-driven methods. Long-term priorities consist of incorporating progressive technologies, such as, NLP, and machine learning to support research services and evolving institution-wide AI governance frameworks. The improvement of skill improvement needs to widen away from the 41.7% involvement ratio in AI workshops over planned mentorship and constant professional growth. Libraries at unpredictable phases of AI implementation should assume a phased approach associated with institutional objectives and resource competences.

Future Research Scope

It is also necessary that consistent future research should carry out in-depth studies into user satisfaction, economic benefit analysis, and institutional willingness for AI-driven transformation.

Looking in a broader scope of the studies, a large variety of educational institutions across India can offer acceptable understandings. Additional investigation of evolving AI technologies and the expansion of contextually significant, customizable AI solutions for Indian academic libraries is crucial. Even though, it may propose evidence-based direction for sustainable AI incorporation in academic libraries, this type of research will improve universal LIS scholarship.

CONCLUSION

The study successfully achieved all its objectives by analytically examining the AI technologies used in IIT libraries. It evaluated their advantages and challenges. It also assessed their impact on user satisfaction and service delivery. The outcomes validated that AI implementation is both significant and impactful. Around 75% of the IIT libraries are presently using AI tools in reference services, acquisitions, and plagiarism detection. The library staff also observed robust optimistic results, mainly enhanced competence, personalization, and service quality, echoed in mean scores greater than 4.0. Though, there may be interludes in training, developing duties, and uneasiness about data privacy yet they shape the institutional willingness. These outcomes emphasized that AI implementation is systematically efficient, continuous determinations are necessary to reinforce capabilities and indicate implementation hurdles.

Declaration of Interest

The author(s) declare(s) that there is no conflicts of interest regarding the publication of this manuscript.

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