



Smart Libraries in the Age of Artificial Intelligence: Evaluating the Transformation of Traditional Library Services

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ABSTRACT

Background: The rapid expansion of artificial intelligence (AI) has redefined how libraries acquire, organize, and disseminate information. Smart libraries integrate AI, the Internet of Things (IoT), and cloud computing to transform traditional, staff-intensive services into personalized, always-available knowledge environments. **Purpose:** This study evaluates how AI-based technologies are transforming traditional library services and examines users' awareness, usage, perceived impact, satisfaction, and challenges associated with smart library adoption. **Methodology:** The study used a quantitative, cross-sectional survey design. The respondents were 300 students, faculty, researchers and library staff selected by stratified random sampling using a structured questionnaire with 5 point likert scale. Descriptive statistics, frequency distributions and cross-tabulation were used to analyze the data with SPSS 27. **Findings:** Overall, the results show a high level of agreement that AI improves library service delivery with the Service Transformation construct having the highest mean score ($M = 3.83$, $SD = 0.89$) and the User Satisfaction construct ($M = 3.71$). Perceptions of AI-enabled services ($M = 3.70$) were higher than actual usage in several instances, and perceived barriers to use (such as cost, privacy, and lack of training) averaged $M = 3.52$. **Implications:** The results suggest that library administrators and policymakers should prioritize enhancing digital infrastructure, capacity development for their staff, and robust data-privacy frameworks to drive faster AI-powered service transformation.



Introduction

Libraries are a historical part of the knowledge organization, preservation and dissemination process and have developed in parallel with each significant change in information technology. Each change, from printed catalogues and card indexes to Online Public Access Catalogues (OPACs) and integrated library management systems, has aimed to enhance access, efficiency,

and user experience (Shahzad et al., 2024). The latest – and perhaps most disruptive – change is the use of artificial intelligence (AI) – which is transforming the nature and role of a library.

Artificial intelligence (AI) is a term that describes computational systems that can carry out tasks that normally require human intelligence, such as natural language understanding, pattern recognition, and decision-making (Jha, 2023). AI is being used in libraries in a variety of ways, such as chatbots and virtual reference assistants to offer 24/7 user service, recommender systems to tailor resource discovery, Radio Frequency Identification (RFID) for automated circulation and inventory management, and machine-learning algorithms for predictive collection development, metadata creation, and advanced information retrieval (Cox et al., 2019; Ali et al., 2023). All these technologies contribute to the development of the smart library, which is an intelligent environment equipped with sensors and data-driven to adapt to individual users in real time (Patil et al., 2025).

The smart library concept is an extension of the digital-library and hybrid-library models, which include the intelligence in services, spaces, and workflows. While the digital library enhances content beyond print, the smart library introduces cognition, which is the ability to understand and predict user behavior, thereby providing personalized outcomes (Baber et al., 2024). The COVID-19 pandemic has further accelerated this shift as it has exposed the vulnerabilities of relying only on physical services and has made AI-powered remote services a strategic imperative for institutions globally (Gul & Bano, 2019).

While there has been significant investment in AI around the world, uptake in libraries is not uniform. Highly resourced academic and national libraries in North America, East Asia and Europe are experimenting with generative AI reference services, robotic shelving, and voice-based discovery tools; many libraries in developing regions continue to struggle with infrastructure, funding, and staff digital competence (Kareem, 2026; Wheatley & Hervieux, 2019). User perceptions, satisfaction, and perceived challenges – all of which play a crucial role in the success of AI investments and the transformation of services – remain underexamined, especially within the South-Asian context (Ullah et al., 2026).

In this context, the current study examines the evolution of the traditional library services from an AI perspective. It explores users' awareness of smart-library technologies, the degree of use of AI-enabled services, their perceived impact on service quality, overall user satisfaction and the barriers that limit their use. In so doing it provides empirical evidence in a debate, which has so far been dominated by conceptual and case-study approaches.

Problem Statement

While AI-powered tools offer the potential for quicker retrieval, customized recommendations, and 24/7 access, the majority of libraries, particularly in the developing world, continue to operate with conventional, human-driven processes. There is a lack of research on users' actual awareness and use of AI services, perceptions of service transformation, and the barriers that prevent its adoption. Library administrators will otherwise be at risk of investing in technologies that are not reaching or meeting the needs of their user community. This study thus examines the traditional library services and the enablers and barriers that drive their transformation by the use of AI.

Literature Review

From Traditional to Smart Libraries: An Evolutionary Perspective

The general consensus is that libraries have undergone four phases, namely, traditional, automated, digital and smart, where each phase introduced a new technology (Myla, 2026; Singh, 2025). The smart library is not only characterised by the inclusion of digital content, but also by the intelligence embedded in the system, such as the sensors, algorithms, and networks that transform the library into an active part of the user's information journey (Baber et al., 2024).

AI Applications in Contemporary Library Services

A growing body of research documents specific AI applications. It has been demonstrated that chatbots and virtual reference assistants can handle up to 70% of routine inquiries, thereby freeing up librarians' time for more valuable tasks (Affum, 2023). Now, with the influence of e-commerce, recommender systems have been adopted for subject-specific resource discovery and reading suggestions (Mark & Taylor, 2026). The implementation of RFID and IoT technologies can facilitate real-time inventory, self-checkout, and smart shelving, which significantly reduce misplacement rates (Ali et al., 2023). In more recent times, the use of generative AI for research assistance, summarizing literature and creating metadata has been explored (Miao, 2024).

User Perceptions, Satisfaction, and Impact

The user attitudes towards the AI-based library services are generally positive, especially among students and young researchers, as shown in empirical studies. Wheatley and Hervieux (2019) conducted a survey of 40 academic libraries that revealed that users were more satisfied with AI-based reference services than with traditional email reference. The awareness of smart-library services in South Asia is growing quickly, but the use of such services is still lower than the awareness, which implies that there is a gap between the awareness and use (Obi, 2026).

Challenges and Barriers to Adoption

The literature reveals that some of the most frequently cited barriers to AI implementation are the cost of implementation, inadequate digital infrastructure, user and staff digital literacy, data-privacy and security concerns, and resistance to organizational change (Hamad et al., 2024). New aspects of the debate are emerging, including ethical considerations such as algorithmic bias, transparency of decision-making, and reliance on commercial AI platforms (Lund et al., 2023).

Research Gap

The conceptual literature is abundant, but empirical studies that measure all of these constructs (awareness, usage, transformation, satisfaction, and challenges) together in a single framework, and among a mixed user population, are relatively rare. The present study fills this gap.

Research Questions and Objectives

Research Objectives

The study is guided by the following objectives:

1. To assess users' awareness of AI applications in library services.
2. To examine the extent to which users utilize AI-enabled smart library services.
3. To evaluate the perceived impact of AI on the transformation of traditional library services.
4. To measure user satisfaction with AI-enabled library services.
5. To identify the challenges and barriers that constrain the adoption of smart library services.

Research Questions

- RQ1. How aware are users of AI applications currently deployed in libraries?
RQ2. To what extent do users make use of AI-enabled smart library services?
RQ3. How do users perceive the impact of AI on the transformation of traditional library services?
RQ4. What is the level of user satisfaction with AI-enabled library services?
RQ5. What are the major challenges and barriers to the adoption of smart libraries?

Research Methodology

Research Design

The design of the study was quantitative, cross-sectional survey. This method was felt to be suitable as the research was descriptive and evaluative of current user perceptions, and because it would enable data to be gathered from a wide and geographically spread sample in a relatively short period of time.

Population and Sampling

The target population were users and staff of academic, public, special and college libraries. Stratified random sampling was used with strata based on the type of library to achieve proportionality. The final sample comprised 300 respondents, which was enough to allow for descriptive survey research at 95% confidence level and 5.5% margin of error.

Research Instrument

A structured questionnaire was created using constructs found in the literature. It included two components: (i) six demographic items and (ii) twenty statements that were categorized into five constructs: Awareness (3 items), AI Service Usage (4 items), Service Transformation (5 items), User Satisfaction (3 items), and Perceived Challenges (5 items). The statements were all on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

Validity and Reliability

Three senior library and information science faculty members reviewed the content for validity. Pilot test was done with 25 respondents before full administration. The overall instrument had a

Cronbach's alpha of 0.87 and construct-level alphas of 0.79-0.89, all greater than 0.70, reflecting acceptable to good internal consistency.

Data Collection Procedure

The questionnaire was sent both in print and by way of an online form. The data collection was done for eight weeks. It was voluntary, informed consent was requested and responses were anonymous and confidential.

Data Analysis

The data were coded and analyzed with the SPSS software version 27. Demographic characteristics and responses on the construct level were summarized using descriptive statistics: frequencies, percentages, means and standard deviations. Cross-tabulation was used to examine differences between user roles and library types.

Ethical Considerations

The study was conducted in accordance with the ethical guidelines. Participants were told about the purpose of the study, the right to withdraw from the study at any time, and the confidentiality of their responses. No personal information was gathered.

Findings of the Study

Demographic Profile of Respondents

Of the 300 respondents, 55.0% were male and 45.0% were female. The largest age group was 18–25 years (32.0%), followed by 26–35 years (30.0%). The largest occupational group was students (50.0%), followed by faculty (20.0%) and librarians (15.0%). The most frequent use was of university libraries (55.0%) and 72.0% used library services at least once a week. The demographic profile is represented by figure 1.

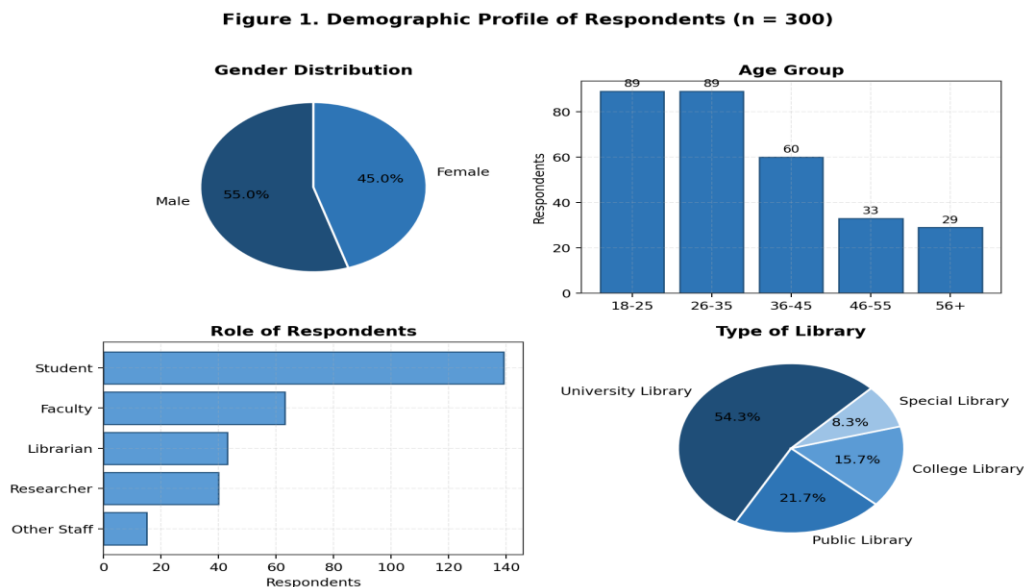


Figure 1. Demographic profile of respondents (n = 300).

Construct-Level Descriptive Statistics

Table 1 presents the mean scores and standard deviations for the five main constructs. All constructs scored above the neutral midpoint (3.0), indicating overall positive perceptions.

Table 1. Construct-Level Mean Scores (n = 300)

Construct	No. of Items	Mean	SD	Interpretation
Awareness of AI in Libraries	3	3.70	0.92	Agree
AI Service Usage	4	3.66	0.91	Agree
Service Transformation	5	3.83	0.89	Agree
User Satisfaction	3	3.71	0.89	Agree
Perceived Challenges	5	3.52	0.94	Agree

The highest mean was found for Service Transformation ($M = 3.83$), which means that users strongly agree that AI is transforming the library service as shown in Figure 2. User Satisfaction ($M = 3.71$) and Awareness ($M = 3.70$) followed closely, and Perceived Challenges ($M = 3.52$) was the lowest but still above the neutral point, indicating that participants also embrace the positive side of AI while acknowledging the challenges.

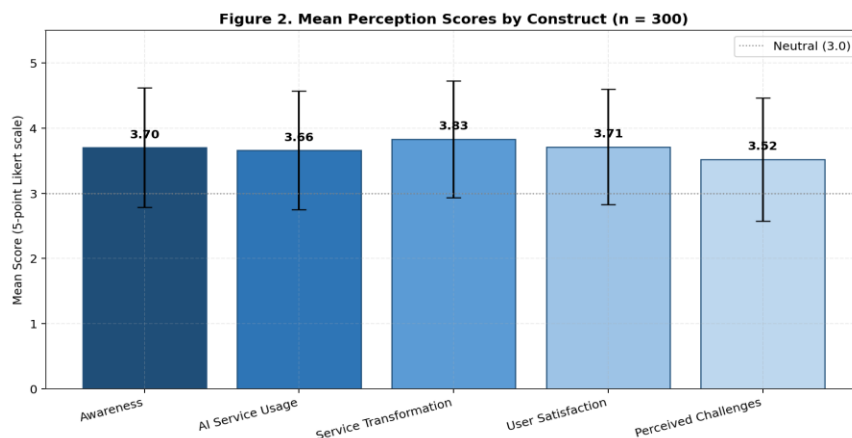


Figure 2. Mean perception scores by construct (n = 300).

Awareness and Usage of AI-Enabled Services

The awareness of AI applications in libraries was also high ($M = 3.70$), and the usage of AI was slightly lower ($M = 3.66$). The results on awareness of the smart-library concept were $M = 3.70$, and the results on the statement "In your own library, AI services have been introduced" were $M = 3.50$, which means that there is a slight gap between the awareness and the implementation. Chatbots ($M = 3.80$) and AI-based search ($M = 3.90$) were found to be the most used services.

Perceived Transformation of Library Services

The respondents strongly agreed that AI can speed up information retrieval ($M = 4.10$) and increase information personalization ($M = 4.00$). There was a bit less enthusiasm for the claim that AI decreases the workload of the staff ($M = 3.80$). As can be seen in figure 3, the majority of

responses were "Agree" or "Strongly Agree" for each of the transformation indicators, with more than 70% of the respondents agreeing with the retrieval speed and resource discovery.

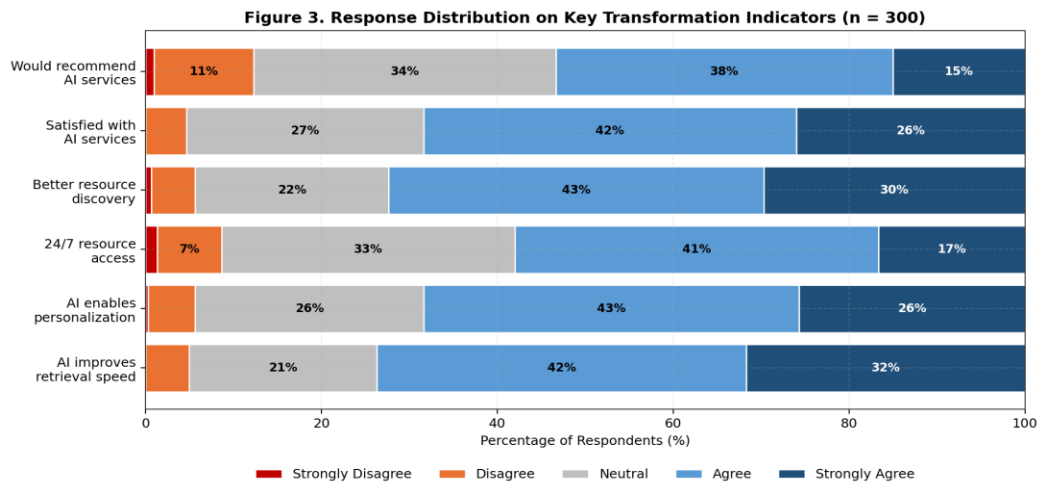


Figure 3. Response distribution on key service-transformation indicators (n = 300).

User Satisfaction

The overall satisfaction with AI-based services was positive ($M = 3.90$) and 68.3% said they would recommend AI-based library services to others. As expected, younger user groups had a higher level of technology exposure, as satisfaction was slightly higher among students ($M = 3.95$) than among library staff ($M = 3.60$).

Perceived Challenges

The challenges with highest scores were high implementation cost ($M = 3.70$), insufficient training ($M = 3.50$), and lack of technical skills among users ($M = 3.60$). As shown in figure 4, privacy concerns were the highest ($M = 3.50$) and staff resistance to change was the lowest ($M = 3.40$).

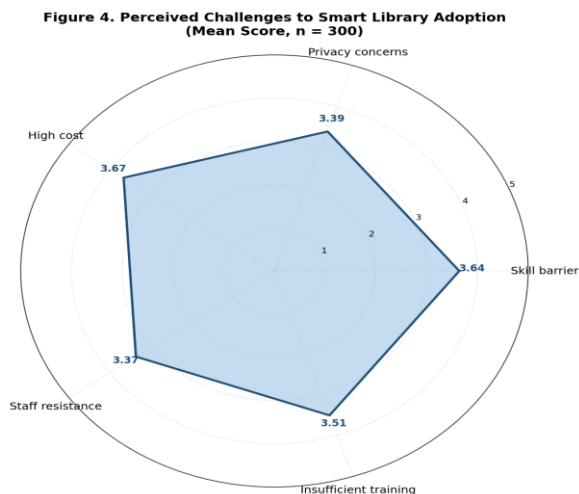


Figure 4. Perceived challenges to smart library adoption (n = 300).

Summary of Findings

Overall, the study validates the generally positive attitude towards smart libraries, including high awareness of the concept, high usage levels, high levels of support for the smart libraries transformation and positive user experiences, as well as the non-trivial but manageable challenges. These findings pave the way to the discussion that follows.

Discussion

The findings of this study confirm and contribute to the growing consensus in the literature that AI is transforming library services. The mean score of the Service Transformation construct ($M = 3.83$) is also consistent with the results of (Bai et al., 2024), who found that AI is not a side experiment in libraries anymore but rather a facilitator for service redesign. This is particularly true for AI-based retrieval speed ($M = 4.10$) and personalization ($M = 4.00$), supporting the claim of (Cao et al., 2018) that intelligent recommendation and search systems are the features of smart library.

The awareness–usage gap observed (awareness of AI services ($M = 3.70$) vs actual usage in several items) is in line with the findings of (Wang et al., 2025) who found a similar gap in South-Asian academic libraries, which they attributed to the lack of hands-on experience and user training. The students' responses indicated a high level of satisfaction ($M = 3.95$), thus corroborating Wheatley and Hervieux's study, which revealed that younger users are more adaptable to AI-based reference services than older users. Interestingly, staff satisfaction was lower ($M = 3.60$), indicating that efforts for transformation must be accompanied by staff-oriented capacity building as (Biswas, 2025) have suggested.

Cost ($M = 3.70$) and training ($M = 3.50$) were the most prominent barriers, consistent with the findings of Bai et al., 2024, that financial and human-resource issues are the two most persistent barriers to AI use in libraries [6]. Furthermore, emerging concerns about data privacy ($M = 3.50$) resonate with the ethical concerns outlined in the study of Lund et al. for the use of generative AI in academic settings. The overall conclusion is that the picture is more complex: AI is delivering real benefits for services, but not consistently and subject to structural, financial and skills factors. The smart library should therefore not be seen as a state to be reached, but as a process and change, which requires policy, investment and the participation of stakeholders.

Research Implications

The study provides practical recommendations for library administrators, policy makers and LIS educators. These findings suggest that investments in AI-powered chatbots and search systems, user and staff training, clear and transparent data-privacy frameworks, and a phased introduction of RFID and IoT solutions should be prioritized. Based on the results, it is recommended that AI, data ethics, and HCI be added to the LIS curriculum so that future librarians can become agents of change in library services.

Limitations of the Study

Some limitations, however, should be taken into account. Firstly, the study relied on self-report perceptions with a Likert scale instrument, which could be subject to social-desirability bias.

Second, the sample of 300 respondents is diverse, but not representative of the entire global library user population, and care must be taken in generalizing the results. Third, a cross sectional design will show attitudes at a single point in time, and will not be able to track the development of attitudes as AI evolves. Fourth, only subjective measures of performance, specifically user perceptions, were used in the study; objective measures such as retrieval accuracy, cost savings or system uptime were not measured. Finally, the rapid pace of generative AI development may soon outpace the specific technologies covered in the questionnaire.

Conclusion and Recommendations

The main objective of this study was to evaluate the impact of Artificial Intelligence in the transformation of traditional library services and to identify the facilitators and inhibitors for the transformation. The findings, derived from the 300 academic, public, special and college library users' responses, are consistent and positive. The awareness of the applications of AI in libraries is high, the usage of AI-based services is increasing, especially AI-powered search and chatbots, and users are definitely aware of the role of AI in changing how libraries provide information, personalize their experiences, and make their services available outside of traditional hours. The satisfaction with AI enabled services is positive across user groups, with majority saying that they would recommend the services to others. At the same time, respondents identified the challenges existing in the implementation of smart libraries, such as costs of implementation, lack of training, privacy concerns and digital skills of users and staff, indicating that the transformation to smart libraries is not homogeneous and complete.

Overall, the findings indicate that smart libraries do not only represent a technological upgrade, but a constant process of change in libraries that requires coordinated investment, human-capacity development and ethical governance. Based on these findings, a number of recommendations are made. Libraries should implement these tools in a phased manner, starting with those that have the greatest impact, like AI-powered chatbots, smart search, and RFID-enabled circulation. Library staff need to have the skills to create, manage and assess AI-assisted services and ongoing professional development initiatives should be put in place to ensure this. The gap between awareness and usage as shown in the data will be tackled by structured programmes of user-literacy as part of orientation and information-literacy programmes. It is also important for institutions to have well-defined data-privacy and AI-ethics policies to foster user trust and address potential future challenges. Lastly, a long-term research effort is needed to observe the development of smart library services, to evaluate the objective impacts of smart library services on learning and research results, and to compare the adoption trends between different regions and types of institutions. When taken together, these actions can help ensure that AI-driven transformation leads to real improvements in library services that are equitable, future-focused, and better.

References

1. Affum, M. Q. (2023). The Transformative Impact of Artificial Intelligence on Library Innovation. *Library Philosophy & Practice*, 1.
2. Ali, M. Y., Naeem, S. B., & Bhatti, R. (2020). Artificial intelligence tools and perspectives of university librarians: An overview. *Business Information Review*, 37(3), 116-124.

3. Baber, M., Islam, K., Ullah, A., & Ullah, W. (2024). Libraries in the age of intelligent information: AI-driven solutions. *International Journal of Applied and Scientific Research*, 2(1), 153-176.
4. Bai, Z., Yu, L., Zhao, L., & Wang, W. (2024). Research on the construction and application of a smart library services maturity evaluation system based on CMM. *The Electronic Library*, 42(5), 766-794.
5. Biswas, G. (2025). Artificial Intelligence (AI) impact on library and information service for digital transformation. *Research Journal of Language and Literature Sciences*, 12(3), 11-15.
6. Cao, G., Liang, M., & Li, X. (2018). How to make the library smart? The conceptualization of the smart library. *The electronic library*, 36(5), 811-825.
7. Cox, A. M., Pinfield, S., & Rutter, S. (2019). The intelligent library: Thought leaders' views on the likely impact of artificial intelligence on academic libraries. *Library Hi Tech*, 37(3), 418-435.
8. Gul, S., & Bano, S. (2019). Smart libraries: an emerging and innovative technological habitat of 21st century. *The Electronic Library*, 37(5), 764-783.
9. Hamad, F., Al-Fadel, M., & Shehata, A. M. K. (2024). The level of digital competencies for the provision of smart information service at academic libraries in Jordan. *Global Knowledge, Memory and Communication*, 73(4-5), 614-633.
10. Jha, S. K. (2023). Application of artificial intelligence in libraries and information centers services: prospects and challenges. *Library hi tech news*, 40(7), 1-5.
11. Kareem, Z. (2026). Digital Leadership and Artificial Intelligence Adoption in Shaping Innovative Work Behavior: A Systematic Review. *International Journal of Business Integrity and Technology Advancements*, 2(02), 08-13.
12. Lund, B. D., Wang, T., Mannuru, N. R., Nie, B., Shimray, S., & Wang, Z. (2023). ChatGPT and a new academic reality: Artificial Intelligence-written research papers and the ethics of the large language models in scholarly publishing. *Journal of the Association for Information Science and Technology*, 74(5), 570-581.
13. Mark, S., & Taylor, A. (2026). Smart Libraries in the Age of Artificial Intelligence and Machine Learning: A State-of-the-Art Review. *Journal of Computational Systems & Engineering Insights*, 4(02), 01-11.
14. Miao, R. (2024). Intelligent Library service transformation strategies based on convolutional networks in the Information Age in the context of digital transformation. *Journal of Information & Knowledge Management*, 23(02), 2450028.
15. Myla, A. (2026). Intelligent Library Ecosystems: The Role of AI, Machine Learning, and Emerging Technologies in Higher Education Libraries. *Journal of Computational Systems & Engineering Insights*, 4(01), 48-57.
16. Obi, C. (2026). The role of artificial intelligence in enhancing library services: A systematic review. *International Journal of Librarianship*, 11(1), 33-46.
17. Patil, S. S., Kamble, L. Y., & Bagewadi, P. (2025). Transformative role of artificial intelligence in library management: A review. *Gyankosh-The Journal of Library and Information Management*, 16(1), 27-40.
18. Shahzad, K., Khan, S. A., Iqbal, A., & Javeed, A. M. D. (2024). Identifying university librarians' readiness to adopt artificial intelligence (AI) for innovative learning experiences and smart library services: an empirical investigation. *Global Knowledge, Memory and Communication*.

19. Singh, D. (2025). Artificial intelligence and applications in library and information science (LIS): Transforming the future of libraries. *International Journal of Information Studies*, 17(4).
20. Ullah, A., Ahmed, S., & Li, G. (2026). Artificial Intelligence in Library Services: Advancing Quality Education Through Smart Information Support. *Inverge Journal of Social Sciences*, 5(3), 453-468.
21. Wang, X., Xie, F., Cheng, G., & Shehzadi, K. (2025). Identifying and assessing the risks of artificial intelligence applications in smart libraries: Perspective of technostress. *Information Development*, 02666669251329032.
22. Wheatley, A., & Hervieux, S. (2019). Artificial intelligence in academic libraries: An environmental scan. *Information Services and Use*, 39(4), 347-356.