Empowering University Libraries Through Artificial Intelligence: Applications, Challenges and Solutions

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ABSTRACT

Guided by policies like MOE's Opinions on Accelerating Education Digitalization, this paper explores AI's role in transforming university libraries from "literature warehouses" to "smart service centers", addressing personalized needs and challenges like resource management. In China, SJTU built an "AI+HI" model with a legal knowledge base and 24/7 virtual librarian; BNU developed a full-process AI system. Internationally, UCalgary's "T-Rex" robot achieves 80ms response and cuts 1.5 FTE workload yearly. It analyzes 4 AI application scenarios and 3 challenges, proposing priorities: enhancing accessibility via alliances (e.g., CALIS), establishing AI content traceability, and promoting library-research-teaching collaboration. Conclusion: Problem-oriented standards make AI a "new engine" for library innovation.

Keywords: *Artificial intelligence (AI), University libraries, Smart services, Automated resource management, Human-AI collaboration (AI+HI), CALIS; Ethical traceability.*

1. INTRODUCTION: THE ERA BACKGROUND OF EMPOWERING UNIVERSITY LIBRARIES THROUGH ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) technology is rapidly transforming various fields in today's digital and information age. As essential venues for knowledge dissemination and academic research, this technological trend inevitably deeply affects university libraries. As AI-related technologies such as big data, cloud computing and machine learning mature, their application in university libraries has become essential for improving service quality and efficiency and addressing the diverse needs of teachers and students.

On the one hand, the needs of university teachers and students in knowledge acquisition have become increasingly multifaceted and personalised. They are no longer satisfied with traditional models of library services and expect to obtain accurate information from more intelligent and convenient resources. Thus, the introduction of AI technology can address these needs by providing personalised recommendation services, intelligent consultation and responses and efficient literature retrieval for teachers and students, which significantly improves learning and research efficiency.

On the other hand, university libraries encounter challenges in management and operation. Extensive literary resources demand efficient management and organisation, while library spaces and facilities require rational utilisation and optimisation. AI technology enables automated management of library resources, intelligent inventory management and smart space planning, thereby enhancing management efficiency and service level.

Moreover, university libraries worldwide are actively exploring AI technology applications, thus forming a global trend in intelligent development. In this context, embracing modern developments, actively introducing AI technology to enhance competitiveness and service capabilities and providing effective support for university teaching and scientific research are essential initiatives that should be undertaken by university libraries in China.

AI technology is significantly transforming the service paradigms and core values of university libraries amid the wave of digital transformation in

education. In the *Opinions on Accelerating the Digitalization of Education* (No. 3 of the General Office of the Ministry of Education [2025]), nine national-level departments, including the Ministry of Education, explicitly stated that they aim to 'promote the use of AI to support education reform', facilitating 'intelligent upgrades of curriculum systems, teaching material systems and teaching systems'.[1]

In this context, as critical hubs for knowledge services, university libraries are transitioning from *literature repositories* to *intelligent service centres* through AI technology, leading to numerous replicable and scalable practical cases.

2. PRACTICAL EXAMPLES OF EMPOWERING UNIVERSITY LIBRARIES THROUGH AI

2.1 Practical Examples from Leading Chinese Universities

2.1.1 Shanghai Jiao Tong University: 'AI + HI' Dual-Wheel Drive Model

Shanghai Jiao Tong University Library collaborated with the Chaoxing Group to launch an AI knowledge repository and an AI librarian chatbot called *Jiao Xiaotuan*, marking the first AI application in the library to integrate the DeepSeek large language model in China. Its core functions are as follows:

- Intelligent consultation: it provides 24/7 assistance, support for book photography analysis and instant access to millions of collections;
- Academic analysis: it generates trend reports on cutting-edge research based on literary data; and
- Knowledge atlas: it develops a vertical knowledge base in the legal field to support intelligent Q&A and curriculum development.[2]

2.1.2 Beijing Normal University: Full-Process AI Service System

Beijing Normal University's library has developed a comprehensive framework for AI applications, spanning infrastructure, core business functions, user services, and literacy training:

- Data centre: it combines collection and reader behaviour data to dynamically adjust resource procurement strategies.
- Intelligent selection (AI platform): it recommends highly relevant books by combining subject classifications with historical data.
- Enhanced reading: it automatically extracts core viewpoints from literature, generating a knowledge repository for the *Humanities and Social Sciences Excellent Achievement Award of Chinese Colleges and Universities*.
- AI librarian 'Shi Xiatu': it supports functions such as voice interaction, book renewals and seat reservations.[3]

2.2 International Experience

By dynamically optimising its knowledge base, an AI consultation robot named *T-Rex* by the University of Calgary's library has decreased consultation response time from 5min to 80ms, thus automatically addressing 50% of routine inquiries (e.g. collection queries and borrowing rules) and reducing costs equivalent to 1.5 full-time employees per year.[4]

3. CORE APPLICATIONS OF AI IN UNIVERSITY LIBRARIES

3.1 Automation of Resource Management

AI technology plays a crucial role in the automation of resource management. First, in terms of automated acquisition of library resources, it enables precise prediction of demands for various literary resources by analysing readers' borrowing data, search records and disciplinary development trends through machine learning algorithms. For example, the system automatically identifies relevant high-quality academic articles and periodicals based on increasing research interest in a particular academic field. It then provides detailed recommendations for acquisition to library procurement staff, thereby enhancing the quality and utilisation rate of library resources by avoiding blind purchasing.

Second, AI contributes to automated cataloguing and classification. Automatic identification, classification and indexing of literature can be achieved using techniques such as intelligent scanning, machine learning, intelligent algorithms and language processing, thus signalling

a future trend in literature cataloguing.[5] Natural language processing and image recognition technologies can enable swift and accurate cataloguing and classification of new literary resources in libraries. For example, in the case of ancient literature, traditional cataloguing requires considerable time and effort from professionals in performing text entry, version appraisal and classification labelling. AI technology enables rapid text recognition and entry and uses image analysis to identify the binding and font characteristics of ancient books and automatically match them to corresponding classification standards, which significantly improves cataloguing efficiency.

Inventory management can also be automated. The AI system can monitor the location, status and circulation of library resources in real-time and automatically issue a replenishment reminder when the inventory of a specific literary work falls below an established threshold. Moreover, it can quickly retrieve the desired literature by intelligently identifying and locating books on shelves, thus reducing search time for readers and enhancing the service efficiency of the library.

Furthermore, in terms of digital resource management, AI enables intelligent integration and management of massive electronic literature and databases. Analysing and mining the metadata of digital resources enable precise retrieval and correlation recommendations. For example, when readers search for literature on a certain topic, the system can not only provide related e-books and journal articles but also recommend relevant research reports, academic videos and other resources, thus providing a comprehensive information service.

3.2 In-Depth Academic Support

AI can empower university libraries to provide in-depth support for academic research. On the one hand, it enables a comprehensive analysis of academic literature to extract key information and latent knowledge. It can identify research hotspots, trends and frontier domains, thus offering valuable references for researchers. For example, AI can generate a research map by analysing numerous literary articles in a particular academic field and demonstrating development contexts and critical nodes in research; in this manner, it helps researchers quickly understand the current status and future directions within the field.

On the other hand, AI can provide personalised academic support for researchers. The system can accurately recommend relevant academic resources and research updates using information such as research interests, historical search records and academic achievements. Moreover, AI can assist researchers in academic writing through auxiliary functions, such as conducting grammar checks and standardising literature citations, thus improving the quality and efficiency of manuscript preparation.

Moreover, AI can facilitate academic exchange and collaboration. For instance, it can match potential collaborators on the basis of research directions and interests and offer real-time communication tools by establishing communication platforms among researchers. AI can also help researchers stay informed about recent industry activities and expand academic networks by integrating and recommending information on events such as academic conferences and seminars.

3.3 Space and Process Optimisation

AI plays a crucial role in the optimisation of spaces and processes of university libraries. The intelligent management of library spaces can be achieved to create a *metaverse* within physical spaces that utilise AI technology.

In essence, a metaverse is a virtual-reality (VR) environment that combines virtual spaces constructed using underlying mechanisms such as AI, blockchain, interactive technology, IoT, networking and computing and video game technologies.[6]

Technologies such as AI, the Internet and VR should be applied during the space construction process of university libraries to digitise resources and visualise digital resource spaces, thus enabling seamless integration between library resources and intelligent devices and fostering virtual services in the physical space. For example, Shanghai Library East created a service scenario in which physical and virtual spaces coexist by integrating metaverse-related technologies.[7]

Another example is the precise mastery of use frequencies and peak periods of various areas in university libraries using sensors and data analysis. Appropriate adjustments to desk and bookcase arrangements using these data can optimise space utilisation. Areas with low use frequency can be transformed into small seminar rooms and creative

studios, among others, to meet the diverse learning needs of students.

In terms of process optimisation, AI can enable the streamlining of the borrowing process. With the introduction of self-service borrowing and returning equipment and intelligent recognition technology, students no longer need to queue for manual assistance, because the system can quickly identify a book and complete the borrowing and returning process simply by placing the book in a designated location. In addition, AI facilitates the timely allocation and replenishment of books to avoid shortages in popular books by predicting trends in book borrowing.

Furthermore, AI can optimise libraries' navigation systems. Students can quickly find the specific locations of books using mobile apps or on-site navigation devices. The system can also provide relevant book recommendations and navigational guidance based on students' historical borrowing records and current search needs, thus enabling them to discover more valuable resources. As for the library's opening hours, AI can enable a dynamic adjustment of opening hours based on students' learning habits and needs to enhance the library's service efficiency and resource utilisation.

- Smart space: Tianjin Agricultural University's AI librarian called 'Si Xiaoyuan' supports voice reservation of seats and book location navigation, thereby increasing space utilisation by 28%.[8]
- Process redesign: By integrating data plagiarism detection systems and AI translation tools, Hunan Institute of Technology's AI librarian, called 'Yan Lingxi', decreased business processing time by 70%.[9]

4. CHALLENGES AND ISSUES

4.1 Technological and Security Risks

Data privacy leakage: Sensitive user information, such as borrowing records and consultation content, may be abused. For example, a leakage of data from 100,000 users occurred due to permission vulnerabilities found in a university's AI system.[10]

Algorithm bias: Recommendation systems may reinforce user interests, thus leading to *information cocoons*. A survey indicated that 38% of users reported that AI-recommended content is extremely homogenous.[11]

4.2 Ethical and Copyright Disputes

Content authenticity: AI-generated summaries could contain factual mistakes. For example, a medical thesis was retracted for fabricating clinical trial data using AI.[12]

Copyright ambiguity: AI training data typically involve unauthorised literature, thus posing potential legal risks for university libraries. For example, a database provider sued a university for unauthorised use of AI to obtain literature in 2024.[13]

4.3 Management and Talent Bottleneck

Cost pressure: The annual investment in the deployment of AI systems is approximately 500,000 yuan (including hardware, software and maintenance), which is deemed expensive for central and western universities.[14]

Insufficient staff skills: 85% of library staff lack AI technology operation abilities, while only 12% of universities offer system training.[15]

5. SOLUTION STRATEGIES AND PATHWAYS

5.1 Technology and Security

Data classification protection: Technologies such as federated learning and homomorphic encryption can be adopted. For example, Shandong University deployed the DeepSeek localisation model, thus achieving *usable but invisible* data.[16]

Algorithm auditing mechanisms: A manual review process for AI-recommended content can be established. For example, Shanghai Jiao Tong University's library conducts monthly random inspections on 10% of AI-generated results to rectify deviations.

5.2 Ethical and Standardisation Aspects

Industry standard development: Principles for AI applications should be clarified, prioritising user cultivation and security control according to the Ministry of Education's *Opinions on Accelerating the Digitalization of Education*. For example, Tianjin Agricultural University prohibits the use of AI external network searches to protect the security of academic information.

User empowerment: Transparent data usage options should be provided. For example, Beijing

Normal University permits users to independently disable personalised recommendation functions.

5.3 Talent and Collaboration

Developing talent and collaboration is crucial in response to challenges in AI applications in university libraries. On the one hand, these libraries need to improve AI literacy training for staff. For example, regular professional courses on AI technology that cover basic knowledge, such as machine learning and natural language processing, should be organised to enhance staff's understanding and utilisation of AI tools. Industry experts can be invited to present lectures and engage in discussions to share the latest technology trends and application cases, thus broadening the horizons of the staff.

On the other hand, university libraries should actively collaborate with external institutions. Partnerships with tech companies can be established to co-develop AI application systems suitable for library services, which will enhance libraries' intelligence levels by leveraging corporate technological advantages. For example, libraries can cooperate with leading enterprises in AI technology to develop intelligent retrieval systems, thus improving the accuracy and efficiency of literature retrieval. Alliances with other university libraries can also be formed to share experiences and achievements in AI applications and achieve optimised resource allocation. For example, data mining and analysis projects can be jointly conducted to explore potential academic resources and user needs.

Moreover, university libraries can foster university–industry cooperation with relevant university departments such as computer science and information management. Providing internship opportunities for students will cultivate versatile talents with a comprehensive understanding of library operations and AI technology. Meanwhile, conducting theoretical research and technological innovation in AI applications for libraries by leveraging the research capabilities of universities can contribute to the sustainable development of libraries.

6. CONCLUSION

AI technology is driving the transformation of university libraries from *resource centres* to *knowledge service hubs*. Its value lies not only in significantly improving service efficiency but also in reconstructing the library service ecosystem through the deep integration of AI into human intelligence. Thus, future development should focus on the following aspects.

- Technological accessibility: it is necessary to establish AI tool-sharing mechanisms through industry alliances such as the China Academic Library & Information System to effectively address barriers to technological application for central and western universities.
- Ethical governance: there is a must to establish full-process source-tracing mechanisms for AI-generated content, strengthening content quality protection. An example is the 'Trustworthy AI' system at Shanghai Jiao Tong University's Legal Knowledge Base.
- Ecosystem development: it is also necessary to promote extensive cooperation between libraries and research and teaching systems by implementing the development requirement of the 'integration of artificial intelligence into all elements of education', as advocated by the Ministry of Education.

AI can truly become the *new engine* that steers innovative development in university libraries only by adhering to problem-oriented approaches and strengthening standardised safeguards.

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