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2026 Volume 4, Issue 2
Educational Innovation Research
ISSN: 3029-1844(Print) ISSN: 3029-1852(Online)

Research on the Construction of Artificial Intelligence-Driven Smart Information Service Models in University Libraries

Xiaoxian Qiu*
Library, Lingnan Normal University, Zhanjiang 524048, Guangdong, China

**Author to whom correspondence should be addressed.*

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Abstract: In the context of the rapid development of Artificial Intelligence (AI) technology, university libraries are facing key opportunities and challenges in their transformation from traditional services to smart services. This paper delves into the construction of AI-driven smart information service models for university libraries. By analyzing the current development status and existing problems of smart services in university libraries, and integrating the application scenarios and advantages of AI technology, it proposes a multi-dimensional smart information service model framework covering resource integration, user service, and management operations. The implementation pathways and guarantee mechanisms are systematically elaborated. The research aims to provide theoretical references and practical guidance for university libraries to enhance service efficiency, meet the diverse knowledge needs of faculty and students, and promote the construction of smart libraries.

Keywords: Artificial Intelligence; University Libraries; Smart Information Service; Service Model

Online publication: February 26, 2026

1. Introduction

With the rapid development of information technology, Artificial Intelligence (AI), as a core driver of the new wave of technological revolution, is profoundly changing the development landscape of various industries. As an important base for knowledge dissemination and academic research, the further transformation of university libraries towards smart services on the basis of digitalization and networking has become an inevitable trend. The traditional service model of university libraries, primarily focused on resource storage and passive borrowing, struggles to meet the increasingly personalized and precise knowledge demands of faculty and students. The introduction of AI technology provides a new technical means and development direction for university libraries to break through service bottlenecks and enhance service quality and efficiency[1]. Research on AI-driven smart information service models for university libraries holds significant theoretical and practical importance. Theoretically, it helps enrich research in library science, expand the theoretical system of smart libraries, and provide a theoretical foundation for subsequent research. Practically, it offers specific implementation pathways for university libraries to build intelligent, personalized, and efficient service models, thereby enhancing their core competitiveness and better serving the teaching, research, and talent cultivation missions of higher education

institutions.

2. Development Status of Smart Services in University Libraries

2.1. Development Status of Smart Services in University Libraries

In recent years, significant progress has been made in the construction of smart services in Chinese university libraries. Many have introduced technologies like AI and big data, launching service projects such as smart retrieval, personalized recommendation, and intelligent Q&A. Some have also established new service venues like smart library labs and maker spaces, providing diverse learning and innovation environments for faculty and students[2].

In terms of technology application, the scope of AI application in university libraries continues to expand, but the overall application level remains in its early stages. Most libraries primarily utilize basic AI functions, such as simple voice search and rule-based personalized recommendations, while advanced technologies like deep learning and knowledge graph construction are relatively less applied.

Regarding service models, some libraries have begun experimenting with user-centered smart service models, but the level of personalization, precision, and intelligence in services needs further improvement. Traditional service concepts and management methods constrain smart service development to some extent, with issues like cumbersome service processes, dispersed resources, and poor communication still existing in some libraries[3].

2.2. Problems in Current Smart Services of University Libraries

2.2.1. Insufficient Depth and Low Integration of Technology Applications

Although many university libraries have introduced AI technology, most applications remain at the level of single-technology use, lacking integrated research and comprehensive application of multiple technologies. For example, smart retrieval systems and personalized recommendation systems often operate independently with no data sharing, leading to poor service continuity and synergy. Moreover, the depth of AI application is insufficient, failing to fully leverage its advantages in semantic analysis, knowledge mining, and intelligent decision-making. The level of service intelligence needs further enhancement[1,4].

2.2.2. Inadequate User Needs Exploration and Weak Personalized Service Capability

When implementing smart services, some libraries do not explore user needs deeply enough, offering only simple recommendations based on superficial behavioral data, unable to truly understand users' deep-level academic and potential needs. User profile construction is imperfect, lacking precise grasp of individual user differences. Consequently, the targeting of personalized services is weak, making it difficult to meet the diverse and specialized knowledge demands of faculty and students.

2.2.3. High Difficulty in Resource Integration and Imperfect Sharing Mechanisms

University libraries possess rich collections of physical, digital, and network resources. However, resource integration faces significant challenges due to varying formats and standards of resources, as well as departmental barriers. Data cannot flow seamlessly between different databases, creating "information silos" that hinder effective resource utilization. Additionally, resource sharing mechanisms among university libraries are still imperfect, lacking unified coordination management bodies and sharing platforms, leading to resource waste and redundant construction[1,5].

2.2.4. Shortage of Professional Talent and Insufficient Service Team Capabilities

AI-driven smart services in university libraries require compound talents possessing knowledge in library science, information technology, and AI application skills. However, there is a widespread shortage of professional talent in current university libraries. Existing staff often have limited IT skills and AI application abilities, making it difficult for them to

undertake the construction and operation of smart services. Simultaneously, efforts in training and recruiting professional talent are insufficient, and effective incentive mechanisms are lacking, leading to significant brain drain[3,4].

2.2.5. Prominent Ethical and Security Issues

The application of AI in university libraries also brings a series of ethical and security challenges. For instance, the collection, storage, and use of user data may involve risks of personal privacy breaches. Algorithmic biases in AI may lead to unfair services. The generation and spread of false information may affect the authenticity and credibility of academic research. Furthermore, the security of AI systems faces challenges; cyberattacks, virus infections, etc., could lead to library system paralysis and data loss[6].

3. Construction of an AI-Driven Smart Information Service Model for University Libraries

3.1. Fundamental Principles for Model Construction

3.1.1. User-Centric Principle

Always prioritize user needs as the starting point and goal of services. Deeply understand diverse user needs to provide personalized and precise services. Establish user feedback mechanisms to continuously optimize service content and methods, enhancing user satisfaction and loyalty.

3.1.2. Technology Leadership Principle

Stay abreast of AI development trends, actively introduce advanced AI technologies and concepts, and promote the deep integration of technology and service. Strengthen technological innovation and application demonstrations to continuously improve the library's intelligence level and service effectiveness.

3.1.3. Resource Integration Principle

Break down resource barriers to achieve organic integration and sharing of physical collection resources, digital resources, and network resources. Establish a unified resource management platform for standardized and normalized resource management, improving resource utilization efficiency.

3.1.4. Collaborative Partnership Principle

Strengthen collaboration between university libraries and internal academic departments, research institutions, and enterprises to jointly undertake smart service projects. Establish cross-departmental and cross-institutional cooperation mechanisms to achieve resource sharing and complementary advantages, enhancing the comprehensiveness and innovativeness of services.

3.1.5. Ethical Compliance Principle

Strictly adhere to laws, regulations, and ethical guidelines during AI technology application to safeguard user rights and interests. Strengthen data security and privacy protection, standardize the development and use of AI algorithms, ensuring fairness, impartiality, and transparency of services.

3.2. Framework Design of the Service Model

Based on the above principles, this paper constructs an AI-driven smart information service model framework for university libraries. This framework primarily consists of five layers: the Resource Layer, Technology Layer, Service Layer, User Layer, and Management Layer, as detailed below:

3.2.1. Resource Layer

The Resource Layer is the foundation of smart information services in university libraries. It encompasses physical collection resources, digital resources, network resources, and user data resources. By integrating and standardizing various types of resources, a unified resource database is established to provide data support for upper-layer services. Simultaneously, AI technology is leveraged to deeply process and analyze resources, extracting knowledge units and constructing knowledge graphs to achieve semantic organization and association of resources.

3.2.2. Technology Layer

The Technology Layer is the core driving force of smart information services in university libraries. It primarily includes AI technology, big data technology, Internet of Things (IoT) technology, cloud computing technology, etc. Among these, AI technology is key, covering sub-technologies such as natural language processing, machine learning, computer vision, and knowledge graphs. The integrated application of these technologies enables functions like intelligent resource retrieval, personalized recommendations, and intelligent Q&A. Big data technology is used for the collection, storage, and analysis of user behavior data, resource data, etc., providing a basis for service decision-making. IoT technology enables intelligent management of physical library spaces and equipment. Cloud computing technology provides powerful computing power and storage support for smart services.

3.2.3. Service Layer

The Service Layer is the concrete manifestation of smart information services in university libraries. Based on different user needs and service scenarios, diversified service modules are established, mainly including:

(1) Smart Resource Service Module: Provides intelligent retrieval, resource navigation, document delivery, and other services to facilitate users' rapid access to needed resources.

(2) Personalized Knowledge Service Module: Based on user profiles and knowledge graphs, provides users with personalized resource recommendations, subject information push, research topic tracking, and other services.

(3) Intelligent Consulting Service Module: Provides 24/7 consulting services via intelligent Q&A systems, virtual customer service, etc.

(4) Smart Space Service Module: Enables intelligent management of physical library spaces and personalized services, such as seat reservations, environmental control, and learning space recommendations.

(5) Research Support Service Module: Provides researchers with services like research data management, bibliometric analysis, and academic achievement promotion.

(6) Cultural Dissemination Service Module: Utilizes AI technology to conduct diverse cultural dissemination activities such as digital exhibitions, virtual experiences, and online lectures.

3.2.4. User Layer

The User Layer comprises the target audience of smart information services in university libraries, including different groups such as on-campus faculty and students, alumni, and researchers. By establishing user profiles, user needs, preferences, and behavioral characteristics are deeply understood to provide differentiated services for different users. Users are encouraged to participate in service evaluation and feedback, forming a virtuous interaction cycle between users and the library.

3.2.5. Management Layer

The Management Layer is the guarantee system for smart information services in university libraries, encompassing strategic planning, organizational management, system development, and performance evaluation. By formulating scientific and reasonable development strategies and management systems, the overall planning and supervision of smart service projects are strengthened. A robust performance evaluation indicator system is established to regularly assess and

evaluate the effectiveness of smart services, and service strategies and measures are adjusted promptly.

3.3. Operating Mechanism of the Service Model

3.3.1. Data-Driven Mechanism

Taking data as the core driving force, it comprehensively collects and deeply analyzes data such as user behavior data, resource data, and service data to mine user needs and service patterns, providing a basis for service decisions. Data sharing and exchange mechanisms are established to achieve data interconnection between various departments and systems, ensuring data accuracy, completeness, and timeliness.

3.3.2. Intelligent Decision-Making Mechanism

Based on AI technology, an intelligent decision support system is constructed to perform real-time analysis and prediction of various data during the service process, automatically generating service strategies and plans. For example, based on user borrowing records and search history, the smart recommendation system can automatically adjust recommendation content; based on in-library footfall data, the smart space management system can automatically optimize seat allocation and environmental control strategies.

3.3.3. Collaborative Innovation Mechanism

Strengthen collaboration among internal departments within university libraries and foster industry-university-research partnerships with external institutions to form a collaborative and innovative service ecosystem. Establish cross-departmental project teams to jointly promote the construction and operation of smart service projects; cooperate with university departments and research institutions for academic research and talent cultivation; collaborate with enterprises for technology research and development and service promotion.

3.3.4. Continuous Optimization Mechanism

Establish user feedback and service evaluation mechanisms to regularly collect user opinions and suggestions and assess service quality. Based on user feedback and evaluation results, promptly adjust service content and methods, optimize service processes and system functions, achieving continuous service improvement and upgrading.

4. Implementation Pathways for the AI-Driven Smart Information Service Model in University Libraries

4.1. Strengthening Infrastructure Construction to Consolidate the Foundation for Smart Services

4.1.1. Improving Software and Hardware Facilities

Increase investment in library informatization infrastructure, upgrade hardware facilities such as servers, storage devices, and networking equipment to enhance the library's computing power and storage capacity. Introduce advanced software platforms such as library management systems, intelligent retrieval systems, and personalized recommendation systems to provide technical support for smart services. Simultaneously, strengthen the intelligent renovation of physical library spaces by installing smart access control systems, smart shelves, smart seat management systems, etc., to achieve intelligent operation of library spaces.

4.1.2. Constructing a Unified Data Platform

Establish unified data standards and specifications, integrate and clean various types of library data, and build a unified data platform covering resource data, user data, service data, etc. Utilize big data technology for data storage, management, and analysis to achieve data sharing and reuse, providing a reliable data foundation for smart services. Additionally, strengthen data integration with other campus systems such as campus card systems, academic affairs systems, and

research management systems to expand data source channels.

4.2. Promoting Technology Integration and Application to Enhance Service Intelligence Level

4.2.1. Deepening the Application of AI Technology

Strengthen research and application of AI technology, particularly key technologies like deep learning, knowledge graphs, and natural language processing. Construct a knowledge graph-based resource organization and retrieval system to achieve deep semantic analysis and associative retrieval of literature resources; utilize deep learning algorithms to optimize personalized recommendation models, improving recommendation accuracy and diversity; enhance intelligent Q&A systems to boost natural language understanding and knowledge reasoning capabilities. Actively explore AI applications in other library service areas, such as intelligent acquisition and cataloging and smart storage.

4.2.2. Promoting Integrated Innovation of Multiple Technologies

Promote the integrated application of AI technology with other technologies like big data, IoT, cloud computing, and virtual reality (VR), creating integrated smart service solutions. For example, combine IoT technology to achieve real-time monitoring and management of physical library resources; utilize VR technology to develop immersive reading and virtual exhibition services; leverage cloud computing technology to achieve elastic scaling and on-demand services for library resources. Strengthen collaboration and synergy among different technologies to amplify their combined effects, enhancing the overall service effectiveness of the library.

4.3. Focusing on User-Centricity to Optimize the Personalized Service System

4.3.1. Precisely Constructing User Profiles

Establish a comprehensive user data collection mechanism to comprehensively gather user data, including basic information, borrowing records, search history, browsing history, and activity participation records. Utilize artificial intelligence technology to conduct in-depth analysis of user data, mining user interests, academic needs, behavioral habits, and other characteristics, in order to construct accurate and dynamic user profiles. Users are segmented into different groups based on their profiles, and personalized service strategies are developed for each group. For example, for new students, provide library orientation education, basic resource usage guides, and other services; for research staff, offer professional services such as research data management and bibliometric analysis.

4.3.2. Providing Personalized Services Throughout the Entire User Journey

Deliver a personalized service experience across the entire user interaction journey with the library. Before users enter the library, push personalized library event information and resource recommendations through mobile applications. During users' engagement with library resources, provide services such as intelligent retrieval, literature translation, and citation analysis based on their real-time needs. After users leave the library, continuously track their learning and research progress, pushing related discipline-specific information and research outcomes. Furthermore, customizable service packages can be offered, allowing users to select service content and methods based on their own needs.

4.4. Strengthening Talent Cultivation and Recruitment to Build a High-Quality Service Team

4.4.1. Conducting Targeted Training

Develop systematic talent training plans to provide existing library staff with training in information technology and artificial intelligence technologies. Invite industry experts and technical vendors to conduct special lectures and practical training sessions to enhance staff's technology application skills and innovation awareness. Encourage staff to participate in domestic and international academic exchange activities to stay informed about the latest industry development trends and technological advancements. Simultaneously, establish an internal trainer system, selecting outstanding employees to serve as training instructors to facilitate internal knowledge sharing and skill transfer.

4.4.2. Recruiting Professional Technical Talent

Increase efforts to recruit multi-disciplinary talents with backgrounds in library science, computer science, artificial intelligence, and other related fields. Develop preferential policies to attract outstanding university graduates and industry professionals to join the library team. Provide recruited talent with a good working environment and development opportunities to stimulate their work enthusiasm and creativity. Additionally, collaborate with universities and research institutions to establish talent cultivation bases, training specialized personnel required for smart library services.

4.5. Establishing and Improving Safeguard Mechanisms to Ensure the Effective Operation of the Service Model

4.5.1. Perfecting the Institutional System

Formulate management systems and operating procedures related to smart services, including data management specifications, technology application standards, and service quality assessment methods. Clearly define the responsibilities and authority of various departments and staff, standardizing service processes and operational behaviors. Establish and improve systems for intellectual property protection, data security, and privacy protection to safeguard users' legitimate rights and interests. Meanwhile, promptly revise and improve the systems according to the development of smart services to ensure their applicability and effectiveness.

4.5.2. Strengthening Funding Guarantee

Strive for support from the university and various sectors of society to increase investment in the construction of the smart library. Establish special funds dedicated to technology research and development, equipment procurement, talent cultivation, and other aspects. Actively explore diversified funding channels, such as applying for government research projects, engaging in social cooperation, and soliciting donations, to provide sufficient financial guarantee for the sustainable development of smart services.

4.5.3. Strengthening Risk Management

Establish and improve a risk management system to identify, assess, and control technical risks, security risks, ethical risks, and others that may arise during the implementation of smart services. Develop contingency plans to effectively respond to potential emergencies such as system failures or data breaches. Strengthen the review and supervision of AI algorithms to avoid algorithmic bias and unfairness. Concurrently, conduct regular risk assessments and drills to enhance the library's emergency response capability.

5. Conclusion

Through research on the artificial intelligence-driven smart information service model for university libraries, this paper draws the following main conclusions:

(1) Artificial intelligence technology provides powerful technical support for the smart services of university libraries. It can effectively enhance library service efficiency and user experience, representing an inevitable trend for the innovative development of university libraries.

(2) Although certain progress has been made in the construction of smart services in Chinese university libraries, there are still issues such as insufficient depth in technology application, inadequate exploration of user needs, difficulty in resource integration, and a shortage of professional talent, requiring further optimization and improvement.

(3) An artificial intelligence-driven smart information service model framework for university libraries has been constructed, clarifying the model's components, operating mechanisms, and implementation pathways. This provides systematic theoretical guidance and practical solutions for the construction of smart services in university libraries.

(4) The feasibility and effectiveness of the constructed service model have been verified through case analysis, offering references and insights for other university libraries in their smart service practices.

Disclosure statement

The author declares no conflict of interest.

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