# EXPLORATION AND PRACTICE OF KNOWLEDGE SERVICES IN UNIVERSITY LIBRARIES DRIVEN BY ARTIFICIAL INTELLIGENCE

# EXPLORACIÓN Y PRÁCTICA DE SERVICIOS DE CONOCIMIENTO EN BIBLIOTECAS UNIVERSITARIAS IMPULSADOS POR INTELIGENCIA ARTIFICIAL

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## Abstract

In the era of digital-intelligent transformation, the rapid development of artificial intelligence (AI) technology is reshaping users' knowledge service demands. This transformation is driving university libraries to evolve from a traditional resource-centered model to a knowledge innovation-centered paradigm. This article adopts a case study methodology to systematically review the evolution of knowledge services, from paper-based resource services to intelligent services. Focusing on four key dimensions: technology empowerment, demand-driven approaches, scenario expansion, and ecosystem reconstruction, we innovatively propose an AI-centered, multi-tiered knowledge innovation service matrix covering the technical, demand, scenario, and service layers. Building upon this framework, we use the Beijing Institute of Technology Library as an empirical case study. The article elaborates on the

practical scenarios of the "Five Centers": Resource Collaboration Center, Cultural Heritage Center, Knowledge Innovation Center, Future Learning Center, and International Research Center. Key AI-driven initiatives are presented for enhancing resource provision, cultural communication, decision support, research-learning support, and global academic influence. Findings from both research and practice suggest that AI technology is not only reshaping the entire chain of knowledge production and dissemination within university libraries, but also transforming their role from passive service providers to active agents of innovation, which provides intelligent support for the development of China's "Double First-Class" initiative.

**Keywords:** knowledge services, artificial intelligence, university libraries, future learning, collaborative innovation.

## Resumen

En la era de la transformación digital e inteligente, el rápido desarrollo de la tecnología de inteligencia artificial (IA) está transformando las demandas de los usuarios de servicios de conocimiento. Esta transformación está impulsando a las bibliotecas universitarias a evolucionar de un modelo tradicional centrado en recursos a un paradigma centrado en la innovación del conocimiento. Este artículo adopta una metodología de estudio de caso para revisar sistemáticamente la evolución de los servicios de conocimiento, desde los servicios de recursos en papel hasta los servicios inteligentes. Centrándonos en cuatro dimensiones clave: empoderamiento tecnológico, enfoques basados en la demanda, expansión de escenarios y reconstrucción del ecosistema, proponemos de forma innovadora una matriz de servicios de innovación del conocimiento multinivel centrada en la IA que abarca las capas técnicas, de demanda, de escenarios y de servicio. Partiendo de este marco, se utiliza la Biblioteca del Instituto de Tecnología de Pekín como estudio de caso empírico. El artículo profundiza en los escenarios prácticos de los "Cinco Centros": Centro de Colaboración de Recursos, Centro de Patrimonio Cultural, Centro de Innovación del Conocimiento, Centro de Aprendizaje Futuro y Centro de Investigación Internacional. Se presentan iniciativas clave impulsadas por la IA para mejorar la provisión de recursos, la comunicación cultural, el apoyo a la toma de decisiones, el apoyo a la investigación y el aprendizaje, y la influencia académica global. Los resultados de las investigaciones y de la práctica sugieren que la tecnología de IA no solo está transformando toda la cadena de producción y difusión de conocimiento dentro de las bibliotecas universitarias, sino que también está transformando su papel de proveedores de servicios pasivos a agentes activos de innovación, lo que proporciona un apoyo inteligente para el desarrollo de la iniciativa "Doble Primera Clase" de China.

**Palabras clave:** servicios de conocimiento, inteligencia artificial, bibliotecas universitarias, aprendizaje futuro, innovación colaborativa.

## Introduction

Within the higher education ecosystem, university libraries have consistently fulfilled the core missions of knowledge preservation, knowledge organization, and knowledge dissemination. Their intrinsic nature revolves around providing knowledge services oriented to user needs.[1] Knowledge service constitutes a value-added service that directly addresses user requirements and facilitate user processes, characterized by its intellectual substance and creative nature.[2] Traditional knowledge service models in university

libraries have focused primarily on literature lending, reference consultations, and information literacy education. These models, supported by the development of collection resources and retrieval platforms, have formed a resource-oriented service system. However, against the backdrop of the ongoing digital-intelligent transformation, this passive service model faces significant challenges.

Annual circulation reports released by university libraries universally indicate a sustained decline in the borrowing rates of printed materials, with over 90% of printed collections remaining unborrowed.[3] Faculty and students have shown a rapid increase jn their reliance on electronic resources and research tools, resulting in a shift in knowledge acquisition from traditional print media to digital formats. Furthermore, as the "Double First-Class" university initiative continues to advance, universities are demonstrating a growing demand for strategic intelligence and decision-making support. This calls for libraries to provide robust knowledge support for diverse decision-making scenarios, including discipline development, research analysis, and more.[4]

Amidst this trend of increasingly diverse user demands, Artificial Intelligence (AI) technology presents a pivotal opportunity for the transformation of university libraries knowledge services. AI serves as a vital engine for cultivating and developing new-quality productive forces. Driven by AI, the transformation of knowledge services in university libraries has become inevitable. On the demand side of knowledge services, AI is catalyzing transformations in learning methodologies and research paradigms, creating an urgent need for new knowledge service models. On one hand, there is an increasing demand among faculty and students for personalized and adaptive learning experiences.[5,6] Static library resource repositories often struggle to meet the needs of cross-modal and interdisciplinary resource reorganization.

On the other hand, escalating expectations for research efficiency and knowledge agility highlight the limitations of traditional, metadata-centered resource organization models, which are increasingly inadequate for delivering precise, user-specific knowledge services. On the supply side, AI technology provides a systematic technical architecture that enables the precision and personalization of knowledge services, serving as a key element of their transformation.[7] By leveraging core technologies such as data mining, Natural Language Processing (NLP), and multi-agent collaboration, libraries can offer end-to-end intelligent services across various knowledge service scenarios—from traditional information retrieval and bibliographic management to data processing, precise analysis, and interdisciplinary cooperation—thus empowering knowledge innovation. AI technology is not only reshaping user demands for knowledge services, it is fundamentally redefining the essence of those services, prompting university libraries to evolve into knowledge hubs that actively support innovation.

This paper aims to investigate the evolution of knowledge service models in university libraries under the AI paradigm. By analyzing the current state and developmental trends of both domestic and international research, it seeks to summarize and distil the core characteristics of AI-driven university library knowledge services. Furthermore, it proposes an AI-centric Knowledge Innovation Service Matrix for university libraries. Using the Beijing Institute of Technology Library as an empirical case study, and drawing on practical experience in smart library construction, the paper presents concrete implementation pathways for knowledge innovation services designed to address emerging needs and tasks in learning, research, and decision-making support. This research contributes to elucidating the practical transformation pathways for AI-driven university libraries knowledge services and offers valuable insights to facilitate their transition towards knowledge innovation services.

**Analysis of the Current State of Knowledge Services**

(i)  Emerging Trends in Knowledge Service Research

The evolution of knowledge services in academic libraries has undergone multiple phases—from traditional print-based literature management to the online services of digital libraries, and currently to the AI-driven services of smart libraries. This evolutionary trajectory is intrinsically linked to the digitization of education, advancements in digital technology, transformations in the research ecosystem, and evolving user demands. **Figure 1** illustrates the progression of knowledge services in university libraries across these phases.

Prior to the 1980s, libraries functioned primarily within a print-centric paradigm. Users engaged in knowledge acquisition through physical materials, and library services focused on cataloging, print collection development, and on-site assistance. The advent of computer and database technologies in the 1990s propelled libraries toward automation, laying the groundwork for digital libraries. The rise of library management systems and online catalogs shifted the emphasis of research and practice toward electronic resources. Concurrently, information literacy education gained prominence as a critical research domain, driven by efforts to integrate information technologies into education and research. In the early 2000s, the growth of digital libraries sparked initial conceptualizations of knowledge services. Zhang Xiaolin analyzed the challenges posed by networking and digitization to traditional library services, and defined knowledge services as capability-based support that integrates knowledge retrieval, organization, analysis, and synthesis into users' problem-solving contexts to facilitate knowledge application and innovation.[8] This marked a paradigm shift—from resource access to problem-solving. In response, scholars began exploring novel service models such as subject librarians, team-based collaboration, and open-access initiatives.

By approximately 2010, big data and cloud computing technologies deepened knowledge service capabilities and accelerated related research. In order to support data-intensive scientific research (the Fourth Paradigm), collaborative and innovation-oriented models embedded throughout the research lifecycle gained traction, positioning data management, intelligent Q&A systems, disciplinary analytics, and think-tank development as core research themes.[9,10] Since 2020, technologies such as the metaverse and generative large language models (LLMs) have brought new vitality into the development of smart education and smart libraries. IoT and VR/AR have enabled scenario-based services, while user profiling and knowledge graphs have enhanced the precision of knowledge delivery.

Today, AIGC (Artificial Intelligence Generated Content) is driving profound transformations in knowledge services:

- Service paradigms are shifting from automation to intelligent human-AI collaboration;
- User demands are rapidly escalating from knowledge acquisition to knowledge innovation;
- Knowledge delivery is evolving from single-medium approaches to multimodal, interdisciplinary integration.

These forces are collectively advancing knowledge services toward an intelligent and ecological paradigm, accelerating the transformation of academic libraries into hubs for knowledge innovation (**Figure 1**).
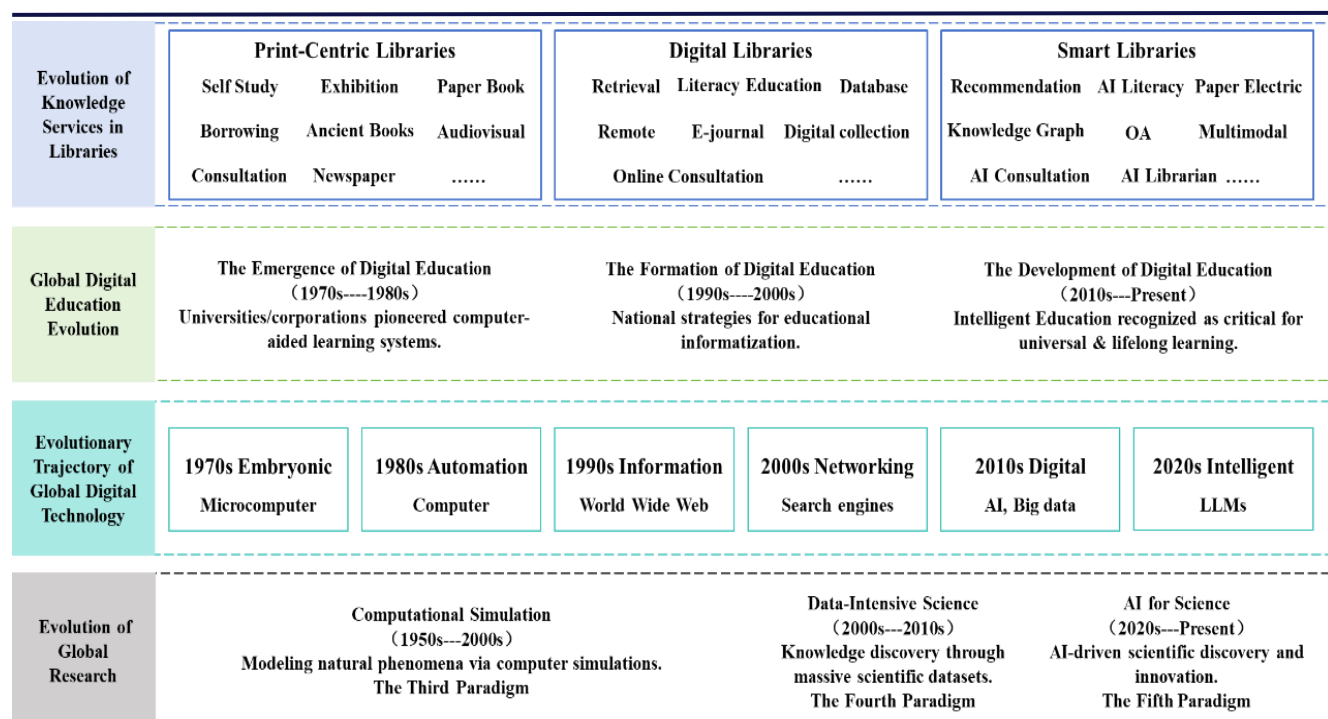
**Figure 1**. Evolutionary Trajectory of Knowledge Services in Academic Libraries
**Source**: own elaboration

(ii) <u>The Emergence of a New Phase in Knowledge Service Development</u>

Artificial intelligence technologies have had a transformative impact on library knowledge services, rendering traditional service models increasingly inadequate in meeting the growing demands of users. Academic institutions around the world have initiated strategic pivots, continuously recalibrating operational frameworks. Empirical evidence indicates that as of September 2023, 107 international scholarly publishers—including Cambridge University Press and Elsevier—have issued policies on the application of generative AI, with 36 of them establishing specialized regulations for large language models.[11] Furthermore, 61 of the top 100 institutions in the 2024 Academic Ranking of World Universities (ARWU)had promulgated normative guidelines addressing the adoption of generative AI.[12]

The International Federation of Library Associations and Institutions (IFLA) articulates in its IFLA Strategy 2024-2029 that libraries should "co-create a sustainable future through knowledge and information for all." Concurrently, the Association of Research Libraries (ARL), in its 2023-2026 Action Plan, explicitly mandates to "represent, advance, and empower research libraries in championing knowledge creation and dissemination." This paradigm shift is evidenced by the growing integration of knowledge services into strategic blueprints of academic libraries, which increasingly prioritize knowledge preservation, discovery, and dissemination to proactively foster knowledge innovation. As presented in **Table 1**, the strategic orientations of 16 globally representative academic libraries demonstrate convergent priorities:

- Harvard University Library asserts its institutional mission to "serve as the global leader in knowledge advancement and scholarly exploration."

- MIT Libraries declares that "the future of knowledge will be decisively determined by libraries."
- Shanghai Jiao Tong University Library aims to develop "a world-class, intelligent, and distinctive information and knowledge service center aligned with leading universities."
- Sichuan University Library is committed to "strengthening the vanguard role of knowledge services" in institutional development.

**Table 1**. The strategic orientations of 16 globally representative academic libraries

| Type | Country | Library Name | Year | Strategic Orientations |
|---|---|---|---|---|
| Overseas | US | Harvard University Library | 2024 | Promote the development of Harvard University in core areas such as learning, research, and the pursuit of truth. |
| | US | MIT Library | 2024 | Promote knowledge openness and sharing, advocate diverse voices and collaborative innovation, empower the future with collective wisdom, and inspire global progress. |
| | UK | SCONUL | 2023-2026 | Will support service sharing, knowledge sharing, and mutual support among peers. |
| | UK | Bodleian Library of Oxford University | 2022-2027 | Ensure that Oxford University remains at the forefront of global academic teaching and research, leading the development of the information world and libraries. |
| | KR | Seoul National University Library | 2024 | Cultivate global leaders through the big data-based knowledge information platform LikeSNU. |
| | AUS | ANU Library | 2024 | Provide excellent information and promotional information services to meet the research, teaching, and learning needs of the university. |
| Domestic | CN | Tsinghua University Library | 2023 | Build a first-class international university library with Tsinghua characteristics, research-oriented digitalization, and open architecture. |
| | CN | Peking University Library | 2023 | Build a literature center, educational platform, cultural hall, and service holy land for all teachers and students in the university. |
| | CN | SJTU Library | 2023 | Becoming an open, interactive, and interconnected knowledge innovation service platform. |

| | CN | Zhejiang University Library | 2025 | Provide first-class literature and information resource guarantee and innovative service ecology for Zhejiang University to build a world-class university and excellent disciplines. |
|---|---|---|---|---|
| | CN | Sichuan University Library | 2023 | Strengthening the leading role of knowledge services and becoming the "spring of knowledge" and "source of innovation". |
| | CN | Wuhan University Library | 2024 | Becoming an important place for students to read extensively, explore various subjects, and obtain various information, a temple for disseminating knowledge, and a second classroom for nurturing talents. |

**Source**: own elaboration

Knowledge service providers across sectors are propelling the iterative advancement of knowledge services through the in-depth application of cutting-edge AI technologies,[13] with **Table 2** delineating 14 globally representative implementations of AI-powered knowledge services. Database vendors are fundamentally reconfiguring traditional resource discovery paradigms by introducing AI-enhanced retrieval and AI-based paper analysis tools.[14] For example, in 2024, Elsevier launched Scopus AI, which generates substantiated textual content based on literature abstracts, and ScienceDirect AI, which enables comprehensive understanding of research by mining full texts from objectives to conclusions.

**Table 2**. Fourteen global archetypes of AI-enabled knowledge service applications

| Type | Year | Tool Name | Company | Description |
|---|---|---|---|---|
| Literature Search | 2025 | WOS AI Assistant | Clarivate | Search enhancement based on WOS core collection citation index data. |
| | 2024 | Scopus AI | Elsevier | Generate text content supported by authentic and reliable literature based on literature abstracts. |
| | 2024 | CNKI AI | CNKI | Support natural language retrieval of literature and original paragraphs of literature. |
| | 2024 | Scite.ai | scite | Using intelligent citations to help researchers better discover and understand research articles. |
| | 2024 | PatSnap Eureka | PatSnap | Accurately interpret the latest intelligence of the monitored enterprise or technology field for users. |
| | 2023 | Research Rabbit | Brooklyn | Quickly and efficiently locate relevant research literature and present a visual network of relationships. |

| | | | | |
|---|---|---|---|---|
| Research Assistance | 2025 | AI Learning | Mita | Generate AI courses from literature and provide diverse expressions based on user level. |
| | 2025 | Science Direct AI | Elsevier | Help users quickly grasp the entire literature from goals, methods to results and conclusions. |
| | 2025 | CNKI Research Assistant | CNKI | Provide AI academic retrieval, AI assisted reading, and AI assisted creative services. |
| | 2025 | Deep Research | Open AI | Deep semantic analysis of cross modal academic resources and generation of professional research reports. |
| | 2023 | Aminer AI | THU | Provide a comprehensive search and mining service network for researchers to socialize. |
| | 2023 | Xinghuo AI | xfyun | Based on professional corpora, provide research results, paper reading, and academic writing services. |
| | 2023 | Scholarcy AI | Scholarcy | Analyze and extract keywords, abstracts, academic highlights, academic summaries, and other content from documents. |
| | 2021 | Wordvice AI | Wordvice | Ensure that research papers and other texts have accurate grammar, appropriate style, and clear expression. |

**Source**: own elaboration

Commercial search engine corporations—as represented by Bing and Google—have emerged as pivotal innovators in the intelligent knowledge services domain. Bing integrates ChatGPT technology into its search engine to deliver more precision-targeted results, while Google leverages its Gemini large model to offer multimodal, conversational search experiences. AI startups such as OpenAI and Metatron have achieved transformative breakthroughs in knowledge interaction through multimodal data processing and knowledge recombination techniques, significantly enhancing the efficiency of specialized knowledge conversion; OpenAI's Deep Academic Search performs cross-modal semantic parsing via multi-agent-augmented retrieval, generating scholarly reports that illuminate pathways for innovation. Metatron's "Learn Today" system dynamically generates AI-driven learning content from scholarly literature and adjusts instructional difficulty and expressive styles based on users' cognitive levels, which overcomes the limitation of static, linear learning models by providing a personalized knowledge acquisition framework.

A collaborative AI ecosystemis now taking shape—spanning academic institutions, traditional publishers, search giants, and AI startups—collectively advancing the transformation from "knowledge provision" to co-innovation. This shift calls for libraries to evolve from knowledge providers into active partners in knowledge co-creation.

**Innovative Knowledge Service Matrix**

In the era of large-scale AI models, the application value of technology will go beyond technology itself, leading to profound changes in knowledge services and reshaping the processes of knowledge acquisition, storage, organization, and sharing. As a frontier in knowledge services, libraries are actively exploring service innovations empowered by AI technologies, building new collaborative frameworks, and promoting knowledge innovation with a results-oriented approach. To address the evolving demands brought by the AI revolution in the knowledge services landscape, this article proposes and constructs an AI-driven knowledge service innovation matrix. **Figure 2** illustrates this matrix, which takes artificial intelligence as its core technological foundation. It revolves around four directions: "technology empowerment, demand-driven approaches, service optimization, and scenario expansion", constructing a multi-dimensional innovation framework that covers the technical, demand, scenario, and service layers. Through the deep integration of technology and services, it drives the transformation of libraries into knowledge innovation centers.
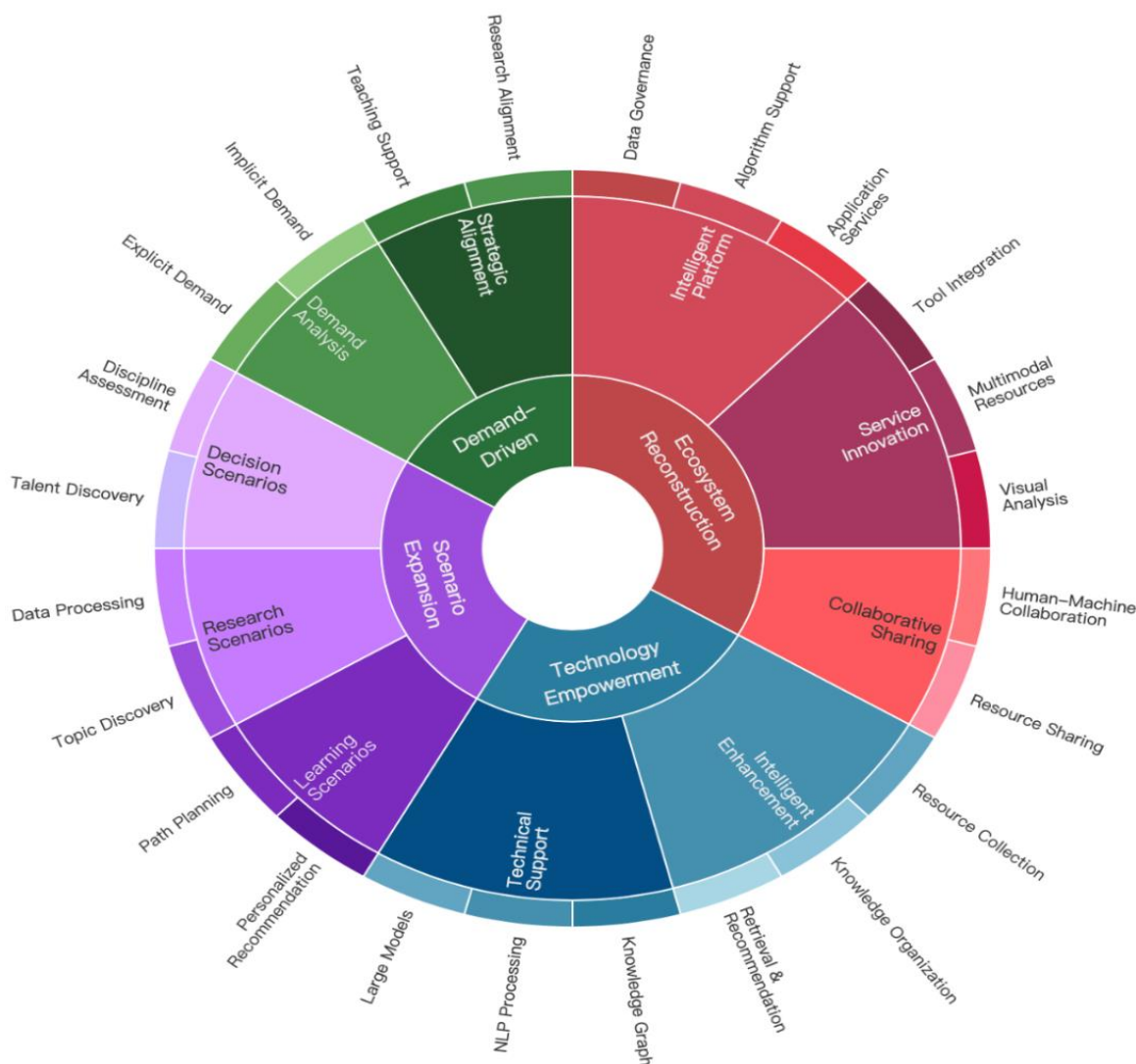


**Figure 2.** Knowledge innovation service matrix
**Source:** own elaboration

(i) <u>Technology Empowerment: Intelligently Enhanced Full-Process Collaboration</u>

The deep application of artificial intelligence technology has redefined the full-process collaborative mechanisms of knowledge services in university libraries. The construction of the knowledge service innovation matrix adopts AI technologies as its foundational architecture, relying on core technologies such as machine learning, knowledge graphs, and large language models. These technologies are deeply integrated into key processes such as resource acquisition, knowledge organization, retrieval and recommendation, and knowledge interaction, enabling end-to-end enhancement from data governance to knowledge augmentation and creation.

At the level of technology application, natural language processing (NLP) and knowledge graph technologies can deeply process massive volumes of literature, facilitating the intelligent integration of multi-source heterogeneous data.[15] For example, semantic indexing can be applied to build dynamic course and subject knowledge graphs, optimizing the relevance and granularity of knowledge structures. Collaborative filtering and clustering algorithms based on deep learning can classify and tag resources, and perform data-driven learning, analysis, and prediction. Application scenarios include not only intelligent classification and recommendation of literature, but also extend to interdisciplinary knowledge discovery. At the same time, human-machine collaboration models are driving qualitative improvements in service capacity: intelligent consulting robots provide 24/7 information consulting and knowledge push.[16] AI-powered frontier prediction tools assist in accurately identifying research directions, promoting a shift in knowledge production from experience-driven to data-driven models. Taking AI-enhanced resource retrieval as an example, its natural language interaction significantly improves search efficiency. On the input side, NLP technologies are used to deconstruct complex user query intentions and expand search terms, thereby improving both recall and precision. On the output side, the system can not only automatically generate knowledge products such as literature abstracts and citations, but also infer users' potential knowledge needs through analytical insights.

Technology empowerment also requires the establishment of ethical standards and mechanisms for continuous innovation. In terms of privacy and security, federated learning technology enables "data availability without visibility," avoiding the leakage of sensitive information. Algorithmic transparency builds user trust through interpretable tools, while retaining manual service channels to meet personalized needs. With the maturation of multimodal large models, cross-modal knowledge retrieval will propel services toward "holographic interaction" experiences, further expanding the core value of libraries in the knowledge innovation ecosystem.

(ii) <u>Demand-Driven: Precision Services Driven by Needs</u>

The AI-driven knowledge service innovation matrix is demand-driven, achieving a closed loop from demand pull to precise matching in libraries through multi-dimensional demand stratification and technological empowerment across the dimensions of "explicit-implicit, short-term-long-term, and individual-group" needs. This initiative promotes the transformation of university libraries from a "resource supply" to a "demand-driven" service paradigm, continuously enhancing user satisfaction and service effectiveness, and building the foundational framework for knowledge service innovation in the AI era for university libraries.

Demand analysis is the foundation of precise services. It involves the integration of multimodal data fusion technologies, combining various data sources such as user basic information, behavior logs, and academic collaboration networks. In-depth mining of demand characteristics across different user groups, such as faculty and students, enables the construction of dynamically updated user profiles, providing precise and personalized input for service recommendations. Taking research support services as an example, by leveraging the semantic analysis capabilities of AI, large language models can be combined with domain-specific knowledge graphs to extract users' knowledge needs from data such as publications, patents, subject directions, and project topics, thereby creating individual academic profiles. Based on these refined profiles, university libraries can implement comprehensive, multi-tiered, and personalized precision services. In the field of resource recommendation, algorithms are continuously optimized through user profiles to accurately recommend cutting-edge literature, learning pathways, thematic databases, and multimedia resources, improving knowledge acquisition efficiency. Additionally, user usage data and recommendation click data can serve as references for library resource acquisition and service evaluation.[17]

Demand-driven knowledge services must not only shift from passive response to proactive perception, but also establish a mechanism that connects individual needs with organizational strategies. As an important carrier of knowledge services, university libraries should actively integrate strategic demands related to school education and teaching, talent cultivation, and scientific research into the knowledge service system. By precisely identifying and synthesizing the needs of various entities within the university, libraries can organically connect these needs with the university's strategic planning, thus forming a tightly integrated knowledge service chain.

(iii) Scenario Expansion: Value Chain Extension through Cross-Domain Collaboration

Empowered by artificial intelligence technology, university library service scenarios must evolve beyond the traditional reader-centered linear model toward diversified scenarios such as learning, research support, and strategic decision-making, thereby building a cross-disciplinary, cross-departmental, and cross-border knowledge service ecosystem.

In learning scenarios, AI technology promotes deep collaboration between libraries and internal university departments such as academic affairs and graduate schools, integrating into the entire process of education and teaching. Traditional library services have focused on providing learning resources, while AI technologies can leverage intelligent recommendation algorithms to dynamically analyze student learning behavior data, achieving personalized learning resource matching and learning path planning. Additionally, for faculty and students' lifelong learning scenarios, libraries can leverage external collaborative resources to integrate massive high-quality online courses, academic lectures, cutting-edge reports, and other resources. Through intelligent filtering and targeted recommendation, they meet the diverse learning needs of faculty and students at different stages and with varied professional backgrounds, providing continuous knowledge support for personal career development and academic growth.[18]

In research scenarios, AI technology empowers libraries to provide knowledge services embedded across the entire research lifecycle. In the phase of topic selection, libraries can help researchers quickly sort out research trends and hot topics in specific fields, providing systematic and detailed literature intelligence that accelerates academic discovery and enhances the foresight and innovation of research

topics. In the phase of data collection and management, libraries can assist in collecting, organizing, and analyzing research data, providing strong data support in key links such as experimental design and data validation. In the manuscript writing and submission phase, generative AI tools can assist in translating and polishing academic texts. In the academic dissemination phase, they can monitor and predict citations and collaboration networks in real-time. From project proposal and implementation to final reporting, libraries can deliver precisely matched knowledge services that advance research innovation.

In decision-making scenarios, libraries support the strategic decisions of various functional departments across the university by integrating multi-source data and using AI technologies to enhance data processing and analysis capabilities. By integrating academic achievements, research dynamics, and talent information, they can help the university accurately identify and introduce outstanding talents aligned with disciplinary development goals. Through in-depth analysis of academic disciplines, they provide factual basis for discipline planning, assisting the university in rational resource allocation, and clarifying key points and directions for discipline development.

The data-driven decision support model enables libraries to transition from traditional service execution to active participation in strategic planning, thereby playing a more critical role in the overall development of the university.

(iv) <u>Ecosystem Reconstruction: Intelligent-Driven Systemic Upgrade</u>

Driven by artificial intelligence technology, the infrastructure and service models of knowledge services in university libraries are undergoing systemic upgrades. By building intelligent system platforms, re-engineering knowledge service processes, and collaborating with internal and external knowledge resources, a new knowledge service innovation ecosystem is being constructed, achieving a leap from efficiency improvement to value creation.

Supported by an intelligent information system platform, a collaborative "data-algorithm-application" platform is built to serve as the technological engine for knowledge service innovation. At the data governance layer, multi-source heterogeneous resources are integrated, and interaction channels between resource data and university faculty and student data are opened, constructing a cross-modal knowledge network. At the algorithm layer, knowledge graphs, natural language processing models, and large language models are integrated to form a middle-platform of algorithmic services covering knowledge organization, demand matching, and decision analysis.

At the application service layer, agile deployment of scenario-based knowledge services such as research assistance and teaching support is achieved through standardized interfaces and visualized terminals. Focusing on the needs of the entire service chain, a complete operation and maintenance mechanism is established to ensure platform stability and security, providing flexible technical support for the continuous evolution of the knowledge service ecosystem.

Relying on intelligent platforms, the knowledge service chain is reconstructed, achieving fundamental changes in service models through full-process reengineering. In the field of research support, an innovative service chain covering "topic discovery - data governance - achievement transformation" is constructed. Through knowledge graphs, insights into disciplinary frontiers are obtained, and intelligent

tools are integrated to assist in experimental design, data annotation, and academic dissemination, promoting a shift in research from experience-driven to data-driven paradigms. In the field of teaching support, a closed-loop service chain of "course design - resource recommendation - effect evaluation" is built. Adaptive learning algorithms are used to analyze the demand characteristics of faculty and students, achieving precise matching of multimodal resources and cross-course knowledge correlation, and constructing a collaborative channel for knowledge delivery and competency cultivation. In the field of decision services, a decision support chain of "data collection - intelligent analysis - strategic output" is formed, deeply integrating academic achievements, talent information, and discipline dynamics, presenting multi-dimensional analysis results through visualization modeling, empowering institutional strategic planning and resource optimization. Full-process re-engineering breaks through the boundaries of traditional service, enabling a model leap from passive response to proactive engagement.

AI-driven knowledge service innovation breaks institutional boundaries, building an open and shared ecosystem through a multi-dimensional collaborative network. At the internal collaboration level, an efficient human-machine collaboration mechanism is established, where intelligent systems handle standardized service demands, freeing librarians' to focus their professional capabilities on high-value knowledge production. At the campus collaboration level, internal data interaction channels are opened, and an institutional knowledge base is built, forming a synergistic network of teaching, research, and knowledge services. At the cross-border collaboration level, regional resource-sharing platforms are accessed, connecting to global academic resource networks, and extending knowledge services to industry-academia-research collaborative innovation, promoting the precise alignment of academic achievements with industrial needs. Through the three-level extension of the library, campus, and society, the library evolved from a closed knowledge repository into an open and innovative hub for knowledge exchange.

## Exploration and Practice: Knowledge Innovation Services

The Beijing Institute of Technology Library traces its origins to the Yan'an Institute of Natural Sciences Library, established in 1940. Its knowledge service efforts began in the 1980s; with the promulgation of the Patent Law, the library started providing patent intelligence services to the university. In 1989, the library established an intelligence teaching and research section. In 1998, a reference and consulting department was established. In the 2000s, library knowledge services began to grow. In 2005, the Information Resource Management Research Institute was established. In 2006, the library was authorized to confer master's degrees in Information Science. In 2009, the Discipline Services and Scientific and Technological Novelty Search Department, along with the Strategic Intelligence Research Department, were established. From 2010 onwards, library knowledge services began to flourish. In 2010, the library was approved as a Ministry of Education Scientific and Technological Novelty Search Workstation. In the same year, it was granted the authority to confer master's degrees in library, Information and Archival Management at the first-level discipline. Since 2020, with the acceleration of digitalization and intelligent transformation, the library's knowledge services have entered a new stage of development, striving to build a high-level, intelligent, and distinctive knowledge service system that is embedded throughout the entire processes of talent cultivation, scientific research, and management decision-making. Looking to the future, the library is actively studying and implementing the spirit of the "Education Power Outline," and focusing on the connotations of

intelligent education and green education, it is building the "Five Centers" knowledge innovation service paradigm for the Smart Library of Beijing Institute of Technology (**Figure 3**).
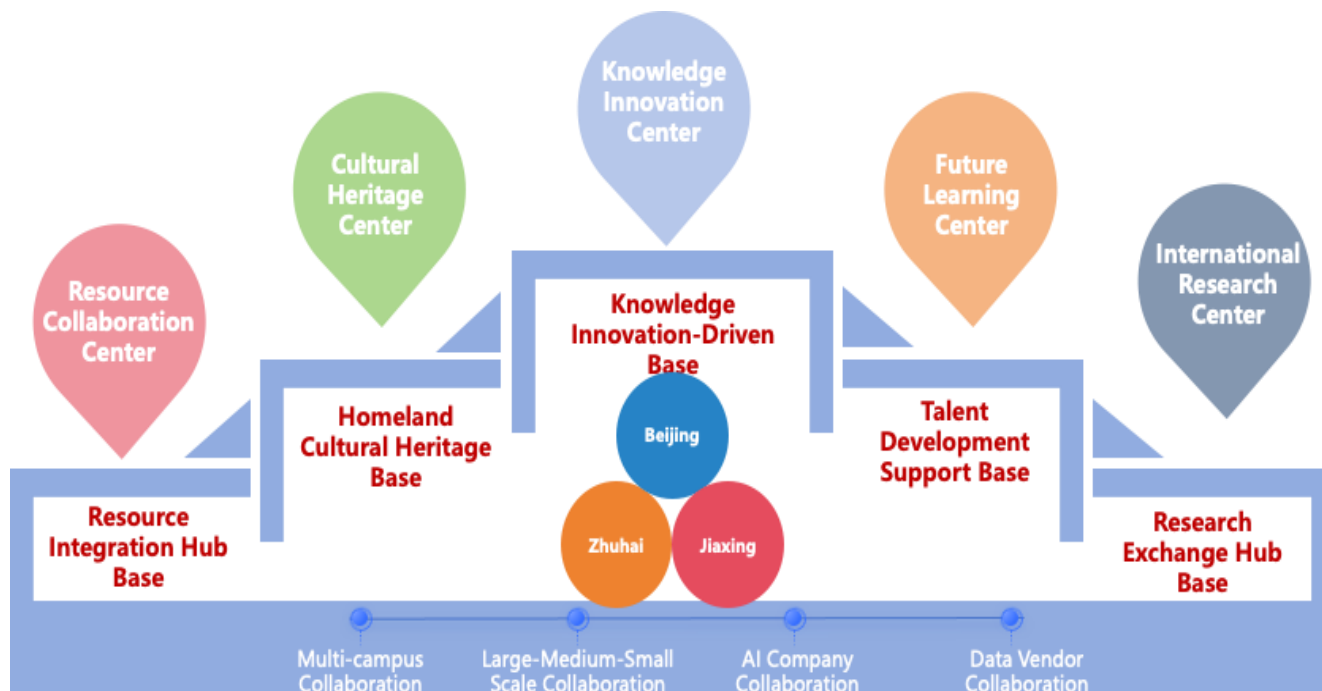


**Figure 3**. Innovative Knowledge Services Paradigm for Library
**Source**: own elaboration

(i) <u>Resource Collaboration Center</u>

At the Resource Collaboration Center, the library focuses on key disciplinary areas of "top engineering, high-quality science, refined humanities, and emerging interdisciplinary fields." Adhering to the construction philosophy of "demand-oriented, high-quality, distinctive, and sustainable," it is building a precise, full-chain literature resource construction system to meet the research and learning needs of faculty and students.

Driven by AI technology, a collaborative resource construction mechanism of "demand-driven - intelligent evaluation - dynamic optimization" is established. Prior to resource acquisition, services are front-loaded by increasing resource trials and conducting in-depth surveys on resource demands of faculty and student at the school level. At the same time, machine learning technologies are employed to analyze data such as publications, patents, and teaching content to accurately identify resource gaps. During resource acquisition, various activities such as thematic book exhibitions, themed seminars, and on-site book selections are held. Stakeholders including academicians, responsible professors, subject librarians, and students are invited to participate, creating an integrated online–offline acquisition model. After resource acquisition, emphasis is placed on evaluating the effectiveness of resource services across, multiple dimensions, including resource trials, paper citation assurance, disciplinary coverage, and high-end database assurance, thereby enabling dynamic resource allocation.

To meet the requirements of the "Double First-Class" Initiative, the Resource Collaboration Center has innovatively implemented a cross-campus collaborative service model. Through integrated construction of print and electronic resources, resource interconnection and intelligent allocation across multiple campuses in Beijing, Zhuhai, and Jiaxing are achieved. As a result of these initiatives, the university's high-level publication output has increased significantly. In the Soft Science ranking for the metric "Library provides sufficient books and electronic resources," the university's ranking percentile has leaped from 50% to 5% between 2022 and 2024.

(ii) <u>Cultural Heritage Center</u>

At the Cultural Heritage Center, the Beijing Institute of Technology Library is guided by the spiritual and cultural core of "Yan'an Roots, Military Industry Spirit, and Leadership Commitment," and is driven by artificial intelligence technology to build a new pattern of "grand ideological and political education".

By deeply excavating the university's historical archives and systematically organizing its special collections since its founding in 1940, the center revitalizes and unearths historical materials. It has launched a series of exhibitions on founding pioneers, such as "Forever the Great Master, Former President Xu Teli Memorial Exhibition" and "Red Legend, Former President Li Qiang. Memorial Exhibition" In the Xu Teli Memorial Exhibition, naked-eye AR technology is used to recreate the historical scene of "reading under the osmanthus tree," generating a 3D interactive experience of his former residence. Combined with AI-based vinyl restoration, this creates an immersive cultural communication mode. A student docent team has also been formed to provide AR-assisted interpretation of historical scenes, promoting practical education that "entering the mind, heart, and action". In parallel, the "Digital Exhibition Hall of Scientist Spirit" supports cross-campus cloud exhibitions, realizing the "Li Qiang Revolutionary Journey" tour across three campuses, significantly enhancing the effectiveness of cultural dissemination through technology empowerment.

The library utilizes AI technologies to build an intelligent platform for ideological and political education. By extracting unstructured data such as scientists' oral interviews and biographies, it constructs a multimodal knowledge graph to enable intelligent correlation between historical events and interpersonal relationships. Based on this, the first branch of the Scientist Museum was established in 2024. At the same time, through AI-driven interactive forms, a case archive of scientist spirit has been created to support integrated construction of ideological and political education across primary, secondary, and higher education. This led to the museum's recognition as a Haidian District Practice Base in 2024, transforming static archives into dynamic educational resources and building a new ecosystem of cultural heritage that blends tradition and technology.

(iii) <u>Knowledge Innovation Center</u>

At the Knowledge Innovation Center, the Beijing Institute of Technology Library harnesses multi-source data, focusing on three core dimensions: talent cultivation, discipline construction, and decision support. It deepens the connotative development of "Double First-Class" universities, building a new paradigm of knowledge innovation services and constructing an intelligent knowledge service ecosystem for the high-quality development of universities.

In terms of talent cultivation, a global talent discovery map platform has been developed based on the world's largest scientific literature database. The platform uses indicators such as research topics and Field-Weighted Citation Impact (FWCI) to accurately identify top talents, assisting the university's recruitment efforts. At the same time, it integrates indicators such as paper impact, patent value, and international collaboration to provide data support for recruitment evaluation and professional title reviews.

In terms of discipline construction, various domestic and international data sources are aggregated to monitor the dynamics of discipline development based on academic publication data. Through discipline benchmarking analysis, potential discipline directions are precisely identified, and global competitiveness analysis reports for emerging interdisciplinary fields such as nanoscience and engineering are completed, providing decision-making basis for the university's discipline resource allocation.

In terms of decision support, aligned with the university's strategic priorities, the center supports national scientific and technological decision-making. The technical challenge "How to apply brain-computer interface technology to clinical medicine" was condensed and selected as one of the 29 major scientific and technological challenges by the China Association for Science and Technology in 2023. Sixteen issues of the "Science and Technology Frontier Monitoring Report" have been completed, and an innovative cross-disciplinary analysis model for extreme environments has been developed to support the university's interdisciplinary strategic research.

(iv) <u>Future Learning Center</u>

At the Future Learning Center, the Beijing Institute of Technology Library seizes the opportunity presented by the Ministry of Education's "AI+" comprehensive reform initiative, taking the "5A" smart learning paradigm as its core concept. Through AI technology, it reshapes educational scenarios and builds an innovative learning service system that is "all-time, all-scenario, and all-chain."

In terms of framework design, an intelligent online learning platform is constructed, integrating functions such as course learning and community interaction to achieve "one-click access" for convenient services. Offline, a smart research and learning space is created, including functional areas such as broadcasting studios and roadshow areas, supporting project-based and scenario-based deep learning. At the same time, a smart service system featuring multi-terminal interconnection breaks through temporal and spatial constraints, building a ubiquitous learning ecosystem. In terms of resource provision, an innovative resource supply model is adopted, using knowledge graph technology to establish an evolvable knowledge space. In terms of service upgrading, a support system featuring "AI Course - AI Tool - AI Librarian" is built to cultivate AI information literacy among faculty and students. In terms of technological application, the center collaborates with leading enterprises to develop vertical-domain knowledge bases, introducing AI tools into teaching and research activities.

Through spatial reconstruction, technological empowerment, and organizational innovation, the Future Learning Center promotes the transformation of university libraries from traditional knowledge repositories into intelligent service hubs, providing innovative infrastructure for cultivating new-quality productive forces.

(v) <u>International Research Center</u>

The International Research Center at the Beijing Institute of Technology (BIT) aims to build a globally oriented knowledge innovation ecosystem. Leveraging artificial intelligence technologies and in-depth cooperations with leading international enterprises, the center has constructed a comprehensive, distinctive, and opened international exchange service system rooted in the university, connecting internal and external resources, and looking globally, to amplify BIT's academic voice and enhance its international reputation.

The center has built the PURE scientific research achievement intelligent management platform to create an international academic profile, expanded new channels for promotion, and enhanced academic reputation. The platform has completed the establishment of institutional and scholar archives at the departmental level, cleaned and integrated academic achievement data from all full-time faculty, and improved scholar visibility through search engine optimization algorithms, significantly enhancing the global reach of the university's high-level publications. Within two months of its launch, the platform reached an index volume of 93,900 pages and exceeded 8,000 weekly visits.

In addition, the International Research Center leverages its spatial resource advantages to build a new multi-interactive platform that fosters innovation and integration. Focusing on international frontier academic data, the center collaborates with top domestic and international database providers, and integrates global high-quality academic resources. It has innovatively constructed an integrated model of "space + resources + services", creating a cluster of smart research and learning spaces, hosting high-end think tank conferences, opening new tracks for international research collaboration, and cultivating a favorable scientific and educational innovation ecosystem.

## Conclusions

AI-driven knowledge service innovation transcends institutional boundaries by constructing an open and shared ecosystem through a multi-dimensional collaborative network. This transformation promotes the evolution of libraries from closed knowledge repositories to knowledge exchange hubs of openness and innovation. On one hand, it strengthens the service support capabilities for teaching and research within the university; on the other hand, it enables the diffusion of resources to empower regional innovation, integrating library services into the macroscopic framework of smart campus and smart city construction, achieving sustainable development and value multiplication of the knowledge service ecosystem.

Looking to the future, the Beijing Institute of Technology Library is committed to developing a highly forward-looking, innovative, and efficient knowledge innovation service system. Through the deep integration of cutting-edge technologies such as big data and artificial intelligence, it will comprehensively enhance the university's performance in teaching, scientific research, and talent cultivation, thereby strengthening the university's overall strength and competitiveness, and provide strong support for it to move towards the ranks of world-class universities.

At the same time, the library will expand cooperation and exchange with other universities, research institutions, and enterprises to promptly understand industry dynamics and the development of cutting-edge technologies, introduce advanced experience and technologies, and jointly carry out scientific

research projects and talent cultivation cooperation to enhance the university's overall strength and influence.

## Bibliographic references

1. Xia LX, Bai Y, Zhang XY. Integration and reconstruction: A new development pattern of smart library. Journal of Library Science in China. 2018; 44(1): 35-49.
2. Chu JL, Ren JH, Wang J. Comparative analysis of library knowledge service and publishing knowledge service. Documentation, Information & Knowledge. 2021; 38(6): 110-122. [Accessed 25 June 2025] Available in:  https://doi.org/10.13366/j.dik.2021.06.110
3. Chen ZR. Research on the construction strategy of literature resources in university libraries for the new round of undergraduate education teaching review and evaluation. Library Development; 2025-5-9.
4. Yuan Y, Xiao H. Construction of the intelligence service system based on data governance for disciplinary decisionmaking in university libraries. Library. 2022; (12): 57-64.
5. Zhu YH, Zhang JX, Han XB. A new form of personalized learning based on artificial intelligence generated content. e-Education Research. 2025; 46(4): 58-64.
6. Strielkowski W, Grebennikova V, Lisovskiy A, et al. AI-driven adaptive learning for sustainable educational transformation. Sustainable Development; 2024.
7. Shan X, Zhang CY, Li QA, et al. Trends in the development of knowledge services in the AIGC era. Library Theory and Practice. 2025; (1): 47-56.
8. Zhang XL. Towards knowledge services: Seeking development opportunities for library and information services in the 21st century. Journal of Library Science in China. 2000; (5): 30-35.
9. Shao R, Fu XH. Exploration and practice of subject knowledge service for scientific research. Information Studies: Theory & Application. 2016; 39(2): 89-92,123.
10. Xiao TC, Weng CG, Xu Q. Knowledge service in libraries: A literature review. Chinese Journal of Medical Library and Information Science. 2017; 26(7): 36-39.
11. Zhao RX, Yang X, Li J, et al. Knowledge service transformation in the context of AI for science (AI4S): Model evolution and response strategies. Information Studies: Theory & Application. 2025; 48(4): 44-53.
12. Song R, Yu S. Generative AI Policies in Academic Research; 2025.
13. Zhang P, Liu YC. Application and reflection of generative AI in smart subject services of university libraries. Journal of Academic Library and Information Science. 2025; 43(1): 10-16.
14. Houstion AB, Corrado EM. Embracing ChatGPT: Implications of emergent language models for academia and libraries. Technical Services Quarterly. 2023; 40(2): 76-91. [Accessed 27 June 2025] Available in:  https://doi.org/10.1080/07317131.2023.2187110
15. Tang S, Long F. Research on ChatGPT embedded in smart subject services of university libraries under the background of "double first-class". Library Work and Study. 2024; (5): 71-78.
16. Li GZ. The impact of Chat GPT on university library: Business, service, development path. Library Theory and Practice. 2023; (6): 123-128.
17. Huang J. Development Strategy of Human Library Service in Universities Driven by Generative Artificial Intelligence. Library Work and Study. 2025-5-4.
18. Zhao Y, Zhou W. Unlocking ancient wisdom with modern tools: A new approach to the revitalization of ancient texts based on generative artificial intelligence. The Journal of Academic Librarianship. 2025; 51(3): 103055. [Accessed 28 June 2025] Available in: https://doi.org/10.1016/j.acalib.2025.103055

**Conflict of interest:**

The authors declare that they have no conflicts of interest.

**Authors Contribution**

YANG Jing: Conceptualization, Methodology, Validation, Project Administration, Supervision, Writing- original draft, Writing - review & editing.

- WEI Jixun: Conceptualization, Methodology, Validation, Writing- original draft, Writing - review & editing.
- WANG Yimei: Visualization, Writing- original draft.