

Development Pathways for Smart Academic Libraries under the 15th Five-Year Plan

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Abstract: Academic libraries constitute a core pillar of the higher education system and an indispensable component of the national innovation ecosystem. China's 15th Five-Year Plan (2026 – 2030) assigns new strategic imperatives to the smart transformation of academic libraries. Building upon a clarification of the central roles that smart academic libraries are expected to fulfill during this period, this paper systematically analyzes the principal challenges currently confronting library development across four dimensions: resource systems, service models, technology integration, and human capital. It subsequently proposes a multi-dimensional development framework oriented toward the objectives of the 15th Five-Year Plan. The findings demonstrate that achieving high-quality smart library transformation requires the coordinated advancement of data asset activation, full-scenario service innovation, integrated technology governance, and talent capacity building. This paper aims to provide both theoretical reference and practical guidance for academic libraries seeking to fulfill their strategic mandate in a new era of digitally empowered higher education.

Keywords: 15th Five-Year Plan; academic libraries; smart libraries; AI integration; data governance; service innovation

1. Introduction

The 15th Five-Year Plan period (2026–2030) represents a decisive stage in China's comprehensive pursuit of socialist modernization. At the national level, the deep advancement of Digital China construction, the full implementation of the "AI+" initiative, and the deployment of digital-intelligent technologies to empower socioeconomic transformation have collectively elevated smart library development to the status of a systematic national strategic undertaking. The 15th Five-Year Plan explicitly calls for "enhancing the service effectiveness of smart libraries," while the 2026 Government Work Report mandates the implementation of a "public cultural service quality improvement initiative." These policy signals confirm that smart library construction has entered a new phase of top-level strategic prioritization, one that demands a correspondingly elevated level of institutional ambition and operational sophistication from academic libraries across the country.

Academic libraries occupy a uniquely strategic position within this landscape. As the core knowledge infrastructure linking the three pillars of education, science and technology, and talent cultivation, they are far more than repositories of printed materials. During the 14th Five-Year Plan period, China's academic libraries achieved notable progress in resource digitization, networked service delivery, and information-based management, laying a solid foundation for the subsequent phase of smart transformation. Nevertheless, persistent structural challenges—including fragmented resource systems, lagging service models, shallow technology integration, and insufficient talent reserves—continue to constrain the full release of smart library potential, rendering many institutions inadequately equipped to meet the demands of higher education's qualitative development and national strategic priorities [1].

Recent international scholarship has documented parallel trajectories of transformation. Wong and Chan's case study of The Hong Kong Polytechnic University Library illustrates how digital transformation can propel academic libraries from passive knowledge repositories to vibrant, AI-enabled smart environments that actively foster knowledge creation and community engagement [2]. Similarly, Ayinde, Ebiefung, and Oladokun's systematic review of AI adoption in academic libraries identifies both the expanding scope of intelligent applications and the persistent organizational and competency barriers that impede their effective implementation [3]. Kulkanjanapiban and Silwattananusarn's bibliometric analysis further confirms that the most transformative library initiatives are those that integrate AI-driven services systematically across the research lifecycle rather than deploying isolated technological tools

[4]. These findings resonate strongly with the challenges observed in China's academic library sector and underscore the global nature of the smart transformation imperative. The question of how academic libraries can strategically navigate this transformation—balancing technological innovation with institutional capacity, national policy alignment with user-centered service design, and resource investment with measurable outcomes—has therefore become increasingly urgent. This paper proceeds through three principal sections. The first delineates the core strategic roles of smart academic libraries during the 15th Five-Year Plan period. The second diagnoses the major structural challenges currently facing library development. The third proposes concrete development pathways across four interconnected dimensions, offering a coherent framework for high-quality smart library construction in the years ahead.

2. Core Strategic Roles of Smart Academic Libraries During the 15th Five-Year Plan Period

Academic libraries are not isolated service units but deeply embedded nodes within the integrated national strategy for education, science and technology, and talent development. Under the blueprint of the 15th Five-Year Plan, their core roles are undergoing a fundamental shift—from traditional document supply centers toward multi-dimensional strategic knowledge hubs that actively empower national development and university excellence. This repositioning is not merely rhetorical but reflects substantive changes in what academic libraries are expected to contribute, how they are expected to operate, and how their performance is expected to be evaluated.

The 15th Five-Year Plan positions high-level technological self-reliance as a foundational national development strategy, placing heightened demands on universities' capacity to build strategic scientific and technological strength [1]. Smart academic libraries are uniquely positioned to serve this agenda through two complementary mechanisms. On the resource side, they can construct precision-oriented assurance systems following a "frontier-leading and demand-driven" logic, dynamically tracking key national strategic domains such as integrated circuits, artificial intelligence, and quantum technology, while continuously enriching repositories of cutting-edge academic literature, research data, and patent intelligence. The construction of such targeted resource systems requires not only expanded acquisition budgets but also sophisticated knowledge organization frameworks capable of mapping institutional research priorities onto dynamic collection development strategies that respond in near-real-time to shifts in the national research agenda. On the service side, by embedding themselves deeply within the full cycle of scientific research workflows, smart libraries can provide comprehensive knowledge services spanning prospective topic analysis, technology competition intelligence, patent navigation, and research commercialization assessment—transforming the library from a document provider into an indispensable intelligence platform for university-based strategic research [2]. This transition demands that librarians develop new competencies in competitive intelligence, scientometrics, and research impact assessment, moving well beyond the traditional boundaries of reference and information services. Kulkanjanapiban and Silwattananusarn's bibliometric review confirms that the most impactful library transformations are those that systematically integrate intelligent services across the research lifecycle rather than deploying isolated applications [4], directly validating this strategic orientation.

During the 15th Five-Year Plan period, China's higher education system is accelerating its transition toward interdisciplinary integration and competency-based cultivation. Smart academic libraries serve simultaneously as core drivers of this transformation and as key venues for implementing the fundamental educational mission of cultivating virtue and talent. In the educational empowerment dimension, smart libraries leverage "future learning center" environments to support cross-disciplinary learning, deploy artificial intelligence to enable personalized learning and intelligent academic assistance, and upgrade information literacy frameworks into comprehensive "digital academic literacy" systems encompassing data literacy and AI ethics—thereby integrating deeply into the full process of talent cultivation. The conceptual expansion from information literacy to digital academic literacy reflects a broader recognition that contemporary students require not only the ability to locate and evaluate information but also the capacity to critically engage with algorithmically curated content, understand the ethical dimensions of AI-assisted research, and contribute responsibly to data-driven knowledge production. In the cultural transmission dimension, smart libraries employ digital rescue and immersive display technologies to revitalize rare collections and ancient texts, while leveraging smart spaces and new media platforms to construct hybrid online-offline cultural programming that fulfills the library's role in value formation and cultural enrichment. Hazarika's analysis of emerging technology trends from ICICT 2025 highlights the transformative potential of IoT-enabled smart library infrastructure and immersive digital environments in reshaping how users engage with cultural and academic resources [5],

enabling libraries to present heritage materials in formats that resonate with digitally native student populations while preserving scholarly rigor.

The construction practices of smart academic libraries additionally carry significant demonstration value for the broader modernization of China's library sector. The pioneering explorations of academic libraries in data governance, AI application, and smart service model innovation can provide replicable and scalable practical pathways and construction standards for public and specialized libraries nationwide. The diffusion of best practices from leading academic libraries to the broader sector represents an important mechanism for achieving systemic improvement in national knowledge service capacity, particularly given the substantial variation in resources and capabilities across different types of library institutions. Furthermore, through inter-library collaboration, consortium co-construction, and resource sharing, smart libraries can drive the formation of an interconnected national knowledge service ecosystem that transcends institutional boundaries. The established practices of national consortia such as CALIS and CASHL have already laid a solid foundation for the construction of an industry-wide smart library ecosystem, demonstrating that collaborative models can achieve resource efficiencies and service capabilities that no single institution could realize independently.

3. Major Challenges Confronting Smart Academic Library Development

Despite the achievements of the 14th Five-Year Plan period, China's academic libraries face a series of deep-seated and structural contradictions when measured against the elevated requirements of the 15th Five-Year Plan era. These challenges are not merely technical in nature but reflect fundamental tensions between inherited organizational structures and the demands of a rapidly evolving information environment that no incremental adjustment can adequately resolve.

Resources constitute the foundation of smart library construction, and the current core challenge lies in the systemic obstacles impeding the transition from traditional document resource management to the value realization of data assets. The problem of "data silos" is particularly acute: inconsistent data standards across internal business systems have left resource data, user data, and management data fragmented and mutually inaccessible, preventing integrated mining and value release. This fragmentation is not merely a technical problem but reflects deeper organizational patterns in which different library departments have historically operated with considerable autonomy, developing their own data systems and workflows without adequate attention to interoperability. Simultaneously, structural imbalances between resource supply and user demand persist, as existing collections remain predominantly text-based while the development of new resource types—including high-quality disciplinary AI training datasets and full-cycle research data repositories—lags severely behind. Yuan and colleagues' topic modeling analysis of library job advertisements documents the growing institutional recognition of data management as a core library function, yet notes that actual implementation of comprehensive data services remains uneven across institutions [6]. The copyright barriers of commercial databases and insufficient digitization of special collections further constrain the deep development and value regeneration of knowledge resources, creating dependencies on external vendors that limit institutional autonomy and long-term sustainability [3].

The widespread adoption of generative AI technologies has profoundly transformed the information-seeking behaviors and core needs of faculty and students, creating a growing misalignment between library service supply and user expectations. As AI tools dramatically enhance users' capacity for autonomous information retrieval, the value of traditional library services—passive lending, basic search assistance—continues to erode. This disruption is not a temporary perturbation but a structural shift that requires a fundamental reconceptualization of the library's value proposition. Libraries that continue to define their primary function in terms of document access and basic reference services risk progressive marginalization as users increasingly turn to AI-powered alternatives for their routine information needs. Concurrently, the development of higher-order knowledge services remains severely underdeveloped: strategic intelligence services embedded in research workflows, deep knowledge question-and-answer capabilities powered by large language models, and cross-disciplinary innovation support all exhibit significant gaps relative to user demand. Ayinde and colleagues' systematic review identifies the transition from reactive to proactive service models as one of the most critical and most difficult dimensions of AI adoption in academic libraries, noting that institutional inertia and competency gaps frequently prevent libraries from realizing the full potential of available technologies [3]. Academic libraries have yet to complete the fundamental transition from "passive response" to "proactive embedding," leaving them inadequately positioned for the qualitative development imperatives of the

15th Five-Year Plan period [4].

Technology is the core engine of smart transformation, while governance frameworks are the essential guarantee for technology deployment and effectiveness. Both dimensions exhibit critical deficiencies that create mutual constraints. On the technology side, applications remain characterized by "point-scattered, shallow-landing" patterns: IoT, AI, and big data technologies largely operate as isolated tools achieving only localized efficiency improvements, without deep integration into core business processes such as resource construction and knowledge services. Some institutions have invested heavily in hardware infrastructure while neglecting the software integration and process redesign necessary to realize substantive service improvements, resulting in a pattern of technology adoption that generates visible outputs without meaningful transformation of user experience or operational capability. On the governance side, traditional hierarchical management structures are fundamentally misaligned with the agile, cross-departmental collaboration demands of smart library projects. The rigid functional divisions that characterize many library organizations—separating technical services from public services, collection development from user services, IT management from programmatic functions—create coordination costs that impede the rapid iteration and adaptive management required for successful smart library implementation. Hazarika's review of IoT and AI trends in library contexts notes that governance and organizational culture challenges consistently emerge as more significant barriers to smart library development than purely technical obstacles [5]. Coordination mechanisms with key university departments—academic affairs, research management, information technology—remain inadequate, creating barriers to data sharing and operational linkage that prevent libraries from being fully integrated into the university's overall smart campus ecosystem.

Smart librarians constitute the core human capital of smart library construction, and the growing deficit between existing staff competency structures and transformation requirements has become a critical bottleneck. The current workforce remains predominantly oriented toward traditional document services and collection management, with widespread deficiencies in composite skills such as data science, AI application, disciplinary intelligence analysis, and patent navigation. This competency gap reflects both the historical trajectory of library education, which has been slow to incorporate data science and computational methods, and the limited opportunities for in-service professional development in these emerging areas. Systematic digital literacy training programs and performance incentive mechanisms remain underdeveloped, with evaluation systems still anchored to traditional service metrics that provide insufficient recognition for innovative and strategically significant contributions. Shahzad, Khan, and Iqbal's empirical investigation of librarians' readiness to leverage AI for smart library services identifies the absence of structured competency development frameworks and misaligned incentive structures as primary factors limiting the effective adoption of AI capabilities in academic library contexts [7]. Narrow talent recruitment channels and uncompetitive compensation packages further impede the attraction of high-caliber composite professionals in data science and intelligence analysis, creating a talent pipeline problem that cannot be resolved through training alone but requires fundamental changes in how libraries position themselves as employers in competitive labor markets.

4. Development Pathways for Smart Academic Libraries Oriented Toward the 15th Five-Year Plan

To address these challenges, academic libraries must adopt a multi-dimensional, precisely targeted development framework guided by the objectives of the 15th Five-Year Plan, achieving comprehensive high-quality smart transformation and fully realizing their value as strategic knowledge hubs. The four pathways outlined below are conceived as mutually reinforcing rather than sequential, reflecting the systemic nature of the transformation required.

With data asset value realization as the core objective, libraries must dismantle the systemic blockages impeding resource transformation and drive a fundamental restructuring of the resource ecosystem [1]. Data barriers must first be eliminated through the construction of a unified library data platform that establishes standardized data specifications and integrates collection resources, user behavior data, and operational management data into a seamlessly interconnected system, thoroughly resolving the "data silo" problem and enabling the kind of cross-domain analytical work that smart library services require. This platform should be designed with interoperability as a foundational principle, enabling not only internal data integration but also connection with university-wide data infrastructure and national library consortium systems. The resource supply structure must simultaneously be optimized: while maintaining robust traditional academic literature coverage, libraries should prioritize the construction of institutional

repositories, specialized thematic databases, high-quality disciplinary AI training datasets, and full-cycle research data repositories aligned with national strategic priorities and institutional strength disciplines. Yuan and colleagues' analysis of evolving data management functions in academic libraries provides a useful framework for understanding the competencies and infrastructure required to support these new resource types [6]. Libraries should also accelerate the digitization and deep development of special collections and rare texts, transforming these unique holdings from underutilized assets into accessible scholarly resources. Finally, resource value must be activated through the transition from "static collection" to "dynamic operation," employing knowledge graph technologies for deep indexing and knowledge reorganization of collections, thereby completing the upgrade from document assurance to knowledge services and fully releasing the academic and applied value of library holdings [8].

Guided by core user needs, libraries must reconstruct their service value systems and establish a proactive, full-scenario service paradigm based on "AI+HI" (Artificial Intelligence plus Human Intelligence) collaboration [9]. This framework recognizes that the most effective library services of the future will combine the scalability and analytical power of AI systems with the contextual judgment, disciplinary expertise, and relational capabilities that human librarians uniquely provide. Baseline services should be upgraded through intelligent knowledge question-and-answer systems, personalized resource recommendation engines, and precision literature push services powered by large language model technologies, improving both the convenience and precision of routine information services. Research services should be embedded throughout the full research lifecycle, providing comprehensive intelligence services—including prospective topic analysis, technology competition intelligence, patent navigation, and commercialization assessment—for national major science and technology projects, institutional strength disciplines, and key technology breakthrough areas, thereby transforming the library from "document provider" to "research partner." Wong and Chan's documentation of PolyU Library's digital transformation journey demonstrates that this transition is achievable and can generate measurable improvements in research support outcomes when implemented with sustained institutional commitment [2]. Educational services should be integrated across the full talent cultivation cycle through collaboration with academic affairs departments to co-construct future learning centers and build comprehensive "digital academic literacy" curricula encompassing information literacy, data literacy, and AI ethics. Cultural services should further be elevated through immersive smart environments leveraging digital twin and VR/AR technologies to achieve compelling presentation of special collections, fully realizing the library's cultural enrichment and value formation functions.

With dual empowerment through technology and governance as the core approach, libraries must resolve the mutual constraints between these dimensions and establish the underlying support and institutional guarantees for smart transformation. An integrated smart technology platform should be constructed following principles of top-level design, open compatibility, and security controllability, building a "cloud-intelligence integrated" smart library platform based on microservice architecture with data middleware and AI middleware as dual core engines, forming a unified "smart brain" that coordinates all library systems and services. This architectural approach avoids the fragmentation that has characterized many first-generation smart library implementations by establishing shared infrastructure that all library functions can access and build upon, reducing redundancy and enabling more sophisticated cross-functional service development. Internal governance must simultaneously be reformed toward agility by dismantling the departmental silos created by traditional linear functional divisions, constructing flattened, project-based organizational structures, and forming cross-departmental agile project teams suited to the rapid iteration and collaborative advancement demands of smart library initiatives. Kulkanjanapiban and Silwattananusarn's analysis emphasizes that organizational structure and governance culture are as important as technical capability in determining the success of library transformation initiatives [4]. Comprehensive external collaboration mechanisms must further be established with key university departments—academic affairs, research management, information technology—to achieve normalized data sharing and operational coordination, deeply integrating library smart development into the overall smart campus ecosystem and the university's 15th Five-Year Plan.

With "talent-driven library excellence" as the core strategy, libraries must construct a high-quality talent system aligned with smart library development requirements. Talent structure optimization should be pursued by broadening recruitment channels and prioritizing the introduction of professionals in data science, artificial intelligence, disciplinary intelligence analysis, and patent navigation, rapidly addressing composite high-caliber talent deficits. This recruitment strategy should be accompanied by competitive compensation frameworks and clear career development pathways that position library positions as attractive options for professionals with advanced technical skills, countering the perception that libraries offer limited opportunities for those with cutting-edge technological expertise [10]. A

librarian "capacity rebuilding" initiative should be implemented through a stratified, categorized systematic digital literacy and professional skills training framework, employing project-based practice, inter-library exchange, and university-enterprise collaboration to comprehensively enhance staff capabilities in data processing, AI application, and intelligence analysis, driving the systematic transition from traditional librarians to smart librarians. Shahzad and colleagues' empirical findings on AI readiness among university librarians underscore the importance of structured, sustained competency development programs that address both technical skills and the broader professional identity shifts required for effective smart library service delivery [7]. Performance evaluation and incentive mechanisms must finally be reformed by replacing traditional service metric-centered evaluation systems with multi-dimensional frameworks centered on innovation value, service effectiveness, user recognition, and strategic contribution, substantially increasing incentives for innovative work and fully stimulating librarians' transformation motivation and creative vitality.

5. Conclusion

Advancing smart academic library construction oriented toward the 15th Five-Year Plan represents both an inevitable choice for responding to the Digital China construction wave and serving the integrated national strategy of education, science and technology, and talent development, and the core pathway for driving systematic library reinvention and high-quality development. At this critical transformation window, academic libraries must break free from traditional path dependencies and systematically resolve practical challenges through the coordinated advancement of resource reconstruction, service innovation, technology empowerment, and talent reshaping. The four development pathways proposed in this paper are mutually reinforcing: resource system reconstruction provides the data foundation for intelligent services; service model innovation defines the user-facing value proposition that justifies technology investment; technology and governance reform creates the operational infrastructure that enables both; and talent ecosystem development supplies the human capital that animates all other dimensions. Looking ahead, smart academic library construction should closely follow national strategic guidance, continuously iterating development pathways through dynamic optimization, to genuinely become the strategic knowledge hub supporting universities' high-quality development, the core platform empowering scientific research innovation and talent cultivation, and the benchmark leading industry transformation and upgrading—contributing substantial strength to the construction of a strong nation in education, science and technology, and culture. Future research should examine the implementation experiences of specific institutions as they pursue these pathways, generating empirical evidence that can refine and validate the framework proposed here and support evidence-based decision-making by library administrators across diverse institutional contexts.

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