Mechanisms and Strategies for Multi-stakeholder Collaborative Development of Public Smart Libraries

Authors: Li Jiayun, Li Jiayun

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Abstract

Through analyzing the value and mechanisms of multi-stakeholder collaborative advancement in smart library construction, and proposing countermeasures and recommendations, this study provides a theoretical basis for promoting smart library construction and enhancing collaborative capacity. The values of various stakeholders in advancing smart library construction are: policy support to guide construction; market orientation for win-win cooperation; talent foundation for continuous transformation; deep-rooted safeguards to drive upgrades; and participation in construction to enhance effectiveness. Multi-stakeholder collaborative advancement mechanisms are proposed: interaction mechanism; interest mechanism. Strategies for collaborative advancement include: institutional safeguards; communication and coordination; risk control.

Full Text

Multi-Agent Collaboration Mechanisms and Strategies for Promoting Public Smart Library Development

Author: Library of Yunnan Minzu University

Abstract

This paper analyzes the value propositions and collaborative mechanisms of multi-agent joint promotion of smart library development, and proposes corresponding countermeasures and recommendations to provide a theoretical foundation for advancing smart library construction and enhancing collaborative effectiveness. The value contributions of various agents in promoting smart library development include: policy support to guide construction, market-oriented

cooperation for mutual benefit, talent-based sustainable transformation, deep-rooted support to drive upgrades, and participation in construction to improve efficiency. The paper proposes multi-agent collaborative mechanisms encompassing interaction mechanisms and benefit mechanisms, along with strategies for coordinated promotion: institutional guarantees, communication and coordination, and risk control.

Keywords: Library; Smart Library; Government-Enterprise-University-Research-User; Multi-Agent Collaboration

Chinese Library Classification: G252

Author Biography: LI Jiayun (1982-), male, from Kunming, Yunnan, is a librarian at Yunnan Minzu University Library. His research focuses on reading promotion and smart libraries.

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In the digital economy era, new technologies represented by big data, artificial intelligence, Internet of Things, blockchain, and cloud computing have demonstrated significant functions and value in socio-economic development. The *Outline of the 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives Through 2035* of the People's Republic of China points out the need to "accelerate digital development, focusing on key areas such as public libraries and integrated media centers in digital China, to promote the inclusive application of digital services," thereby driving library smart development based on technology application. In response to the requirements of the 14th Five-Year Plan for digital economy development, the State Council issued the *Opinions on Promoting the Implementation of the National Cultural Digitalization Strategy*, which identifies the "national smart library system" as a key construction objective, requiring library services across the country to evolve toward "resource datafication," "data intellectualization," and "knowledge wisdomization," thereby enabling smart empowerment across multiple application scenarios including the publishing industry, management software industry, and document service industry. Against this backdrop, libraries are experiencing profound changes, with the smartification process affecting numerous business operations such as book lending, data display, self-service, and librarian work. Smart library development has become "the inevitable path for libraries to adapt to intelligent development in the artificial intelligence era" [1]. However, China's library smartification construction still faces problems such as "lack of unified standards and unified norms" [2], and in practice, there exists a tendency to "shout slogans, decorate environments, purchase equipment, and push resources" [3], hindering the creation of new smart library scenarios and

the construction of new infrastructure. How to solve these practical problems in promoting smart library construction has become an important proposition for both academia and the industry.

Smart libraries are considered the product of the integration of libraries and information technology, representing an advanced stage of library informatization that emphasizes the application and expansion of artificial intelligence technology in libraries [4]. Building on this foundation, some scholars argue that smart libraries represent innovative development that integrates emerging technologies such as the "Internet of Things, cloud computing, and smartification" [5], realizing a "people-oriented service concept" [6] and further sublimating the value and functions of libraries. Smart libraries enhance the supply and service capabilities of public digital cultural content through specific forms such as upgraded spaces [7], reading services [8], and public services [9]. Current academic research abundantly covers technical applications [11-13], management [14-16], and services [17-19] related to smart library construction standards and norms, as well as practical case studies [20]. Research on multi-agent collaboration mainly focuses on smart services [21-25]. Wang Jing [26] et al., based on SFIC theory, identified "government, universities, smart libraries, industry associations, and users as collaborative construction agents," but did not specifically examine the relationship between various smart library construction agents and their functional responsibilities. Sun Jiangchao [28] found in strategic project implementation research that multi-agent collaboration among government, enterprise, university, research, and user can effectively achieve cooperation, supervision, and mutual benefit among projects. "Government-Enterprise-University-Research-User" refers to the five major agents—government, enterprise, university, research institution, and user—leveraging their respective advantages in strategic innovation processes to achieve resource sharing, risk sharing, benefit sharing, and value co-creation, meeting the requirements for sustainable strategic development. In view of this, this study examines the collaborative relationships among government, enterprise, university, research institution, and readers (users) in promoting smart library development from a multi-agent collaboration perspective: first, clarifying the value of multiple agents in smart library construction; second, analyzing the multiple mechanisms through which the government-enterprise-university-research-user collaboration drives smart library development to clarify the intrinsic connections between agents and smart library construction; finally, proposing strategic choices for multi-agent collaborative promotion based on these mechanisms.

1.1 Policy Support to Guide Construction

As a crucial pillar of the information society, the government provides a favorable policy environment for library smartification development. Smart library construction involves coordination among resources, information, and technology across multiple industries, fields, and departments, including publishing, logistics, electronic information, and real estate, requiring the government to

fulfill its guiding and governance responsibilities to address problems and difficulties in the construction process. Specifically, the government provides crucial measures such as policy and regulatory support, standard formulation [12], and development funding [31] for smart library construction. Emphasis should be placed on the government's comprehensive guiding role in technological innovation, service innovation, and talent development in library smartification, enabling the transformation of government responsibilities to address new tasks, challenges, and objectives in the information era. Meanwhile, relevant government departments coordinate planning and scientifically guide the behaviors of different agents involved in smart library construction, reducing risks caused by insufficient resources and information asymmetry among agents, and promoting in-depth library smartification development.

1.2 Market-Oriented Cooperation for Mutual Benefit

Enterprises serve as essential components in smart library construction, with some mastering "communication networks, information technology, smart terminals, and AR/VR/cloud service ecosystems" [32], while others controlling "content resources, knowledge services, and application innovation capabilities" [32]. They hold important positions in promoting deep integration of libraries and information technology and service innovation. As key stakeholders in library development, enterprises play a leading role in library smartification. Smartification represents both a vision for interest-related enterprises to achieve their own benefits and drive corporate development, and a forward direction for high-quality development of relevant enterprises. The enterprise co-construction model [33] reflects corporate recognition and implementation of the national smart library strategy, which influences the smart library construction process and the overall development of library smartification. Furthermore, enhancing enterprise capabilities is essential for 打通 (打通) industrial chains [34], resource chains [35], service chains [36], value chains [36], knowledge supply chains [37], and innovation chains [35] in library development. Therefore, emphasizing the internal logic of various chains in enterprise promotion of library digitalization, intelligence, and smartification helps lay a solid foundation for comprehensively advancing smart library construction.

1.3 Talent-Based Sustainable Transformation

Universities serve as the main arena for talent cultivation and play a crucial supporting role in smart library construction [38]. To continuously explore new models of smart library construction and facilitate library smartification development, universities need to expand traditional library and information science research fields and objects, providing talent guarantees for smart library construction and development. In response to new talent demands in libraries, universities should actively innovate teaching content and methods, strengthen knowledge and practical skills development, and cultivate high-quality library professionals with contemporary characteristics and requirements to support

new models and development in library smartification. Additionally, emphasis should be placed on "cultivating interdisciplinary composite talents and cooperation among talents and institutions to build academic communities" [39], committed to jointly training library professionals and providing solid talent guarantees for national smart library construction.

1.4 Deep-Rooted Support to Drive Upgrades

Research institutions are important entities independent of government departments, industrial enterprises, and higher education institutions, playing "supporting, bridging, catalyzing, and optimizing" roles in library intelligent transformation [40]. Research institutions encompass various types, including think tanks, technology transfer agencies, and professional intermediary agencies. Compared with higher education institutions, research institutions are more professional and targeted in research capabilities, serving as multifunctional complexes encompassing scientific and technological R&D, theoretical and technological innovation, talent education and training, and scientific and technological cooperation and transformation. They shoulder important missions and responsibilities in promoting innovation, risk undertaking, and technological guarantees in smart library construction. Research institutions possess abundant intellectual, hardware, and talent resources, as well as knowledge and skills, which can provide foundational support for cultivating and delivering outstanding digital resource construction and smart library service talents. Smart library construction requires establishing a team with information technology backgrounds, artificial intelligence-related knowledge, and professional subject librarians to contribute ideas and suggestions. Leveraging technological advantages, research institutions continuously derive new development connotations by formulating general basic norms, professional standards, and key technical specifications in the smartification process. Through tracking research on key technologies, standards, and service applications, research institutions use the latest research findings to guide national library smart management and service construction practices.

1.5 Participation in Construction to Enhance Effectiveness

As the demand side, readers play a crucial goal-oriented role in smart library construction and development. Specifically, readers experience various aspects of smart libraries including technology, platforms, facilities, spaces, collections, and services—such as the maturity of intelligent technology applications, the construction level of basic data and information management platforms, public data sharing platforms, intelligent collaborative platforms, and information network sharing levels—enabling feedback and timely adjustments to improve smart library construction effectiveness. Furthermore, as demanders and consumers of smart products and services, readers have diversified needs for smart library products and services. To continuously meet readers' resource and service requirements, smart libraries are compelled to adopt new technologies for

continuous innovation, achieving transformation in service content and models.

2.1 Interaction Mechanism

Under multi-agent collaboration, different organizations and agents form interdependent cooperative networks through mutual dependence and influence. Specifically, smart library construction cannot form a complete smartification model relying solely on libraries themselves. Issues such as information asymmetry, resource disparities, and benefit distribution conflicts among different agents, if not properly addressed, will hinder smart library construction. However, with proper guidance that fully mobilizes agent vitality, integrates advantageous resources, and fulfills respective responsibilities, close relationships among agents can be promoted to efficiently drive smart library construction. Symbiotic interdependence means that collaborative relationships among different agents serve as the prerequisite for seeking joint construction in the development of smart library smartification. The government maintains policy continuity and coordination during smart library construction, ensuring relevance and cohesion in resource coordination policies to guarantee effective policy implementation.

2.2 Benefit Mechanism

The government formulates corresponding development strategies and local policies to meet public demand for inclusive, basic, and bottom-line cultural services, fully leveraging its guiding role in promoting library smartification and providing policy guidance for other agents to seek collaborative construction, ensuring effective policy implementation. Enterprises actively participate in smart library construction based on their own development, value creation, and profit realization needs. Universities continuously expand their knowledge reserves and achieve dynamic cooperation with relevant government departments, enterprises, and research institutions to promote economic and cultural progress and strengthen faculty knowledge and practical skills. Motivated by considerations of promoting their own discipline construction, talent innovation development, and graduate employment, universities actively assist enterprises in supporting library smartification under favorable policy environments. Research institutions actively engage in smart library construction driven by needs for cutting-edge research deepening, enhancement of scientific and technological innovation capabilities, and applied research and technological development, achieving technological innovation in library smartification through research 成果转化 (成果转化). Readers' needs for cognition and information exploration generate strong awareness for smart learning.

2.3 Alliance Mechanism

The government-enterprise-university-research-user collaborative alliance model involves libraries seeking cooperation with relevant enterprises, universities, and research institutions for resources and technology based on reader needs, utilizing external resources to drive library smartification construction. This model

emerges because closed iterative innovation in libraries has gradually become insufficient to meet new era development demands. In this model, libraries are the demand side of the co-construction alliance, relevant enterprises are the providers, research institutions and universities are the assistants, and government agencies serve as guiding supporters for both supply-demand parties and assistant parties in co-construction activities.

As shown in the diagram, in this model, libraries first analyze reader needs and their own spatial, equipment, and technological disadvantages. After identifying smartification construction needs, they seek co-construction assistance from research institutions and universities. Upon learning of smart library construction needs, co-construction suppliers develop targeted products and technologies, creating 成果 (成果) that can be mastered and applied by the demand side and delivering them to libraries. Libraries must test these products and technologies through reader experiences and provide feedback to co-construction suppliers to correct deviations in the co-construction process, forming a virtuous co-construction cycle. Research institutions and universities follow up collaboratively in co-construction, continuously improving their own capabilities while providing professional talent training services to libraries to enhance staff comprehensive capabilities. The government provides guidance and support to both knowledge supply and demand parties, mobilizing enthusiasm from both sides and creating a favorable public service environment for the cluster.

3.1 Establishing Institutional Guarantees for Multi-Agent Promotion

Smart library construction promotion is influenced by government participation in planning, standards, policies, and supervision, requiring multi-faceted efforts to provide external momentum. The government should strengthen policy publicity and education to enhance policy transparency and influence, enabling multiple agents to understand and correctly interpret government policy orientation, manage relationships between multiple agents and government policies as well as among multiple agents themselves, and properly utilize policies to meet different interest demands. When formulating smart library industry standard policies, the government should emphasize standard operability and enforceability, consider actual conditions, and create targeted solutions. However, most policies regarding smart library smartification construction remain at the macro level, lacking practicality and feasibility, and failing to provide effective support for policy guidance and implementation. Therefore, the government has the responsibility to assume a guiding role, strengthening policy formulation level and enforceability in line with actual conditions. Simultaneously, the government must accelerate office system transformation, highlighting supervision level achievements to promote healthy and sustainable smart library development.

3.2 Establishing Communication and Coordination for Multi-Agent Promotion

Under the collaborative co-construction model, multiple agents possess resource advantages and strong selection and action capabilities. Within this framework, multiple agents can achieve mutual benefit through complementary advantages. However, different understandings and perceptions of collaborative cooperation among multiple agents often lead to disputes that endanger the overall effectiveness of the cooperative structure. Additionally, decision-making capability differences among different agents result in variable execution effects, preventing guaranteed outcomes of collaborative cooperation. To achieve coordinated cooperation among multiple agents, enhance innovation levels, and reduce negative impacts of cooperation risks: first, organize joint conferences to exchange innovation experiences, research findings, and policy implementation status to better collaborate on common problems; second, conduct joint research on areas or issues of common concern, formulate joint research plans, and jointly undertake application of research findings; third, establish cooperative communities to discuss development directions, exchange research findings, share experiences, and provide information to promote mutual cooperation.

3.3 Establishing Risk Control for Multi-Agent Promotion

Smart library construction risks include "technological risks, ethical risks, funding risks, and copyright risks." In this regard: first, before collaborative co-construction, risk factors should be assessed and corresponding emergency plans formulated to provide guarantees for collaborative co-construction; second, contracts should be signed with multiple agents to establish cooperation mechanisms, and partner selection should be strengthened to ensure partner strength and credibility; third, collaborative co-construction generates substantial intellectual property, requiring the establishment of intellectual property protection mechanisms to clarify intellectual property ownership among all participants and achieve true sharing and protection; fourth, establish funding management mechanisms to ensure rational fund use and timely financial information updates; fifth, establish comprehensive information security guarantee mechanisms to prevent data leakage and information security issues that easily occur during data transmission and storage.

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Note: Figure translations are in progress. See original paper for figures.