The Convergence of Metaverse and Libraries: Evolutionary Process, Technological Pathway, Application Practice, and Future Considerations

Authors: Wu Yingchun, Wu Yingchun

Date: 2024-01-26T00:00:00+00:00

Abstract

The article reviews the evolutionary trajectories of the metaverse and libraries, summarizing the fundamental relationship between their integration; elucidates the key technologies for their integration from the perspective of constructing a technical pathway framework for metaverse libraries; describes the difficulties in their integration through the practical applications of the metaverse in public and academic libraries; and finally proposes development recommendations for the integration of metaverse libraries from eight dimensions: concept leadership, institutional planning, collaborative construction and sharing, talent cultivation, risk prevention, cultural inheritance, social education, and ethics.

Full Text

Integration of the Metaverse and Libraries: Evolution, Technical Pathways, Application Practices, and Future Considerations

WU Yingchun
Nanjing Library, Nanjing, 210018

Abstract
This paper examines the integration of the metaverse and libraries by first tracing their respective evolutionary trajectories to identify the fundamental relationship between them. It then elaborates on the key technologies enabling this integration through a framework for constructing metaverse libraries. The challenges of integration are described through application practices in public and university libraries. Finally, the paper proposes development recommendations for metaverse-library integration across eight dimensions: conceptual leadership, institutional planning, collaborative development and resource sharing, talent

cultivation, risk prevention, cultural inheritance, social education, and ethical considerations.

Keywords
Metaverse; Library; Integration; Smartification

With continuous innovation in ideas and information technology, humanity has linked civilization, order, and technology with the "universe," entering a new track called the "metaverse." The metaverse has experienced three major developmental nodes. The first node is the classical metaverse, carried by literature and art forms, exemplified by works such as the *Quran* in the Western world, Petrarch's *Canzoniere*, and Michelangelo's *David*. The second node is the neoclassical metaverse, represented by science fiction and video games, such as Mary Shelley's *Frankenstein* and J.K. Rowling's *Harry Potter*. The third node is the decentralized metaverse in gaming form. In 2003, Linden Lab in San Francisco launched the Open3D-based game *Second Life*. In 2009, Sweden's Mojang Studios developed the sandbox game *Minecraft*. In 2019, Facebook Horizon emerged as a social VR world [1].

A search of authoritative domestic and international databases including Google Scholar, CNKI, and Web of Science reveals that metaverse research primarily focuses on three aspects: first, studies on the metaverse itself, such as identifying its key defining factors [2]; second, research on metaverse applications in gaming, entertainment, and film, including their influence in these domains; and third, metaverse applications and impacts in other fields, including libraries, education, healthcare, and architecture.

As information exchange centers, libraries have long attracted scholarly attention regarding metaverse development [3]. Yang Xinya et al. [4] explored the prospects of metaverse-library integration; Xiang Anling et al. [5] examined the characteristics of virtual-physical application scenarios in metaverse libraries; Wu Jiang et al. [6] studied user information behavior in libraries from a metaverse perspective; and Xu Xin et al. [7] focused on risk prevention in the library industry within metaverse environments. The domestic library community has also convened relevant seminars. In November 2021, Hunan Library held a staff exchange meeting on the "metaverse" theme [8]. In December 2021, at the first National Smart Library Construction Joint Meeting, Deputy Director Huang Chen of Zhejiang University Library shared work practices based on the metaverse theme [9]. In December 2022, the 18th Shenzhen Cultural Fair Metaverse Copyright Forum focused on "metaverse copyright protection and future cultural industry development" [10].

Since 2022, local governments across China have successively released policies related to metaverse-library integration, as shown in .

In summary, by understanding the metaverse's development trajectory both domestically and internationally, China's library community should develop its

own perspectives and innovations rather than blindly following Western models.

What, then, will the metaverse bring to libraries? Which library resources, content, and services can be integrated into the metaverse? What is the future of metaverse-library integration? These questions require joint exploration by practitioners and scholars. This paper takes "metaverse-library integration" as its research entry point, drawing on relevant domestic and international studies to investigate four aspects: evolutionary history, technical pathways, application practices, and future considerations, aiming to provide valuable references for library colleagues.

1.1 Evolutionary History of the Metaverse and Libraries

(1) Library Evolution. Researchers generally agree that library evolution has undergone three main stages [11]. The first stage is the pre-1996 era without networks, characterized by physical libraries with paper-based collections. The second stage spans 1996–2017, marked by digital libraries with information systems as their core feature. The third stage, post-2017, represents smart libraries undergoing deep transformation to provide intelligent services. Physical libraries primarily feature fixed locations and offline manual services facilitated by librarians. Digital libraries focus on digitizing collections and providing dual "online + offline" services through technological advantages. Smart libraries utilize intelligent technologies for comprehensive upgrades, particularly delivering intelligent services through knowledge interconnection.

(2) Metaverse Evolution. The metaverse can be traced back to the 1981 science fiction novel *True Names*, where characters entered another virtual world from reality through a "brain-computer interface" tool. In 1992, science fiction author Neal Stephenson introduced the terms "Metaverse" and "Avatar" in his novel *Snow Crash*, marking the first conceptualization of the metaverse. In 2003, Linden Lab in San Francisco launched the Open3D-based game *Second Life*. Since 2021, the metaverse has entered a fast track of development. "Metaverse's first stock" Roblox was officially listed on the New York Stock Exchange. In October of the same year, Facebook officially changed its name to "Meta," bringing the metaverse into the application market. China has also pursued the metaverse track closely. In November 2021, the China Mobile Communications Federation Metaverse Industry Committee—the first milestone metaverse industry association—was established. In August 2022, the first provincial-level metaverse R&D institution—the Metaverse and Virtual-Reality Interaction Joint Research Institute—was born in Shanghai [12].

In the evolution of the metaverse, *Second Life* represents a pivotal event linking the metaverse with libraries, as shown in .

1.2 Fundamental Relationship Between the Metaverse and Libraries

The metaverse has entered numerous industries, including gaming, finance, education, healthcare, and sports. Within this framework, the metaverse and libraries share a "mutually compatible" fundamental relationship, as illustrated in [Figure 1: see original paper]. Both have remarkably similar developmental histories and identical technological needs, manifested in four aspects: First, both are continuously growing organisms. Second, both follow similar accumulation processes and evolutionary directions, constantly accumulating technology, resources, services, and best practices. Third, both share the same technical support system. The metaverse provides a virtual world parallel to reality through various virtual-physical interaction technologies, blockchain, big data, brain-computer interfaces, and artificial intelligence—technologies that libraries also closely follow, research, and apply. Fourth, both are based on knowledge services and user needs. As venues for information exchange and knowledge dissemination, libraries serve as ports for information and knowledge connectivity in the metaverse, enabling associations among different virtual communities.

Thus, the metaverse and libraries share identical technical support and evolve toward similar directions [13]. On one hand, metaverse development requires leveraging information and knowledge resources from libraries. On the other hand, the metaverse presents new development opportunities and challenges for libraries, broadening the path toward smart libraries. Simultaneously, libraries can empower the metaverse, as library resources and services constitute important elements of the metaverse. The integration of the metaverse and libraries can provide users with three-dimensional immersive services, transitioning from two-dimensional to three-dimensional, from virtual-physical separation to integration, and from single planar vision to multi-sensory experiences.

[Figure 1: see original paper]

2.1 Framework for Constructing Metaverse Library Technical Pathways

This paper establishes a framework for implementing the technical pathways of metaverse-library integration, as shown in [Figure 2: see original paper]. The framework consists of three layers: underlying technical support, front-end device platforms, and scenario content entry points. The underlying technical support includes infrastructure and key technologies, while scenario content encompasses operating environments and application scenarios.

[Figure 2: see original paper]

The metaverse library technical pathway framework is outlined as follows:

(1) Underlying Technical Support: This includes infrastructure and key technologies. Hardware, communication, and computing facilities serve as the infrastructure for metaverse libraries, enabling high-speed communication, uni-

versal connectivity, and resource sharing. Key technologies are detailed below.

(2) Front-End Device Platforms: These primarily include somatosensory devices, three-dimensional imaging equipment, and neural devices, paving the way for scenario content implementation.

(3) Scenario Content: This includes operating environments and application scenarios. In the operating environment, legal systems provide regulatory frameworks for metaverse library operations and financial systems; "virtual humans" in metaverse libraries are also subject to ethical constraints. Application scenarios include scenario construction, data processing, content generation, authentication transactions, and embodied interaction, promoting the construction of smart libraries and playing important roles in cultural inheritance, resource management, reading promotion, and innovation.

2.2 Key Technologies for Metaverse-Library Integration

The metaverse library technical pathway framework clearly illustrates that key technologies for integration include network (5G/6G) communication technology, big data technology, blockchain technology, artificial intelligence technology, and virtual-physical interaction technology.

2.2.1 Network (5G/6G) Communication Technology Network communication technology primarily addresses communication barriers and supports the massive application innovations required by the metaverse. Using access technologies to comprehensively capture human vision, hearing, touch, and motion, it achieves information input and output in the metaverse. The development of metaverse-library integration lies in creating an ecosystem of "universal connectivity and intelligent data fusion."

2.2.2 Big Data Technology As one of the applied technologies for cultural empowerment, big data technology leverages development opportunities to encourage multiple stakeholders to build cultural data platforms based on the national cultural dedicated network, promoting intelligent upgrades of metaverse library system hardware and software. This enables open sharing of original, developmental, and application data, forming a vast new information integration paradigm and achieving seamless connection of the entire data chain in metaverse libraries.

2.2.3 Blockchain Technology Blockchain technology, together with Non-Fungible Token (NFT) and Non-Fungible Rights (NFR) systems, forms a complete barrier providing technical guarantees for the compliant operation of cultural digital production, circulation, rights confirmation, transactions, payments, and copyrights. It also enables the assetization of virtual creations. On one hand, blockchain technology facilitates the construction of digital resource storage, transmission, transaction, and collection management ecosystems in

metaverse libraries, providing technical support for digital resource circulation, sharing, and copyright authentication. On the other hand, the NFT system features interoperability, tradability, and immutability, which help identify, retrieve, and match library digital resources in metaverse environments, enabling data circulation and collaborative governance, as well as unique, non-fungible authentication and transaction management of digital products [14].

2.2.4 Artificial Intelligence Technology As the generative logic, artificial intelligence technology aims to reconstruct the entire landscape of smart management and services in metaverse libraries through speech recognition, image recognition, and natural language processing, building a complete chain from knowledge generation to dissemination to acquisition. In particular, brain-computer interaction will become the mainstream mode of next-generation human-computer interaction, truly achieving immersive experiences for users.

2.2.5 Virtual-Physical Interaction Technology Virtual-physical interaction technology typically includes VR (Virtual Reality), AR (Augmented Reality), and MR (Mediated Reality) technologies. Metaverse libraries utilize XR (Extended Reality) technology to achieve interface interaction among the native world, twin world, and virtual world, making past "ideals" become "reality" and "within reach." Metaverse library virtual-physical interaction serves scenario services and applications to meet user needs, employing XR technology, brain-computer interfaces, virtual guides, and virtual digital humans to create a human-machine symbiotic virtual environment, establishing signal channels for interaction between people and devices, and promoting real-time interaction between users and information in the metaverse.

3.1 Metaverse Library Project Application Practices

Currently, domestic metaverse projects in libraries remain relatively rare and are still in the exploratory stage. Public libraries and university libraries represent the most important branches of China's library system, and elaborating on each provides exemplary significance. In the broader metaverse environment, some public and university libraries have taken proactive steps to seize the metaverse track, actively promoting smart library construction and continuously exploring integration pathways and directions. Through recent years of exploration and practice, libraries have accumulated valuable experience and lessons, providing important references for deeper metaverse-library integration.

3.1.1 Public Library Metaverse Project Practices

Shanghai Library represents the most typical public library in metaverse project applications. When Shanghai Library East began construction in 2018, planners designed several metaverse application projects to propel the transition from digital to smart libraries. Initially, these projects were not called "metaverse," but

gradually became associated with the concept as metaverse development progressed and projects advanced. To date, Shanghai Library has developed four metaverse-related projects: the "Red Cycling" project, the "Family Migration" project, the "NFT Reader Card" project, and the "Ancient Books Blockchain" project [15]. Challenges include the lack of a unified architectural design from the outset, resulting in the absence of a complete platform to connect these projects into an organic whole capable of accommodating all resources and services. Key lessons learned include starting with locally mature, conditional projects for pilot implementation, developing demonstrative applications, and gradually advancing and upgrading to build a metaverse-empowered public library.

3.1.2 University Library Metaverse Project Practices

Chongqing University Library represents the most typical university library in metaverse project applications. The library is constructing metaverse service scenarios and applications to meet readers' real needs, ultimately establishing a metaverse library virtual service application project. Four metaverse projects have been launched: "Virtual Guide," "Virtual Exhibition Hall," "Virtual Digital Human," and "VR Reading," serving as entry points for building the library's virtual service system [16]. Subsequent challenges include the library's failure to break through inherent thinking paradigms and unresolved issues regarding the rights confirmation of digital literature resources. Lessons learned include leveraging the virtualization transformation brought by the metaverse to advance the construction of university library smart systems.

3.2 Practical Difficulties in Metaverse-Library Integration

While the metaverse presents a promising vision for libraries, practical implementation faces numerous difficulties. This paper discusses three main challenges.

3.2.1 Lack of Interoperable Platforms

Based on Shanghai Library's metaverse project practices, the development platforms for metaverse applications lack unified architectural design and comprehensive solutions that address everything from infrastructure to frameworks, content to interaction, and narrative to experience. Consequently, they cannot form an organic whole or a unified interoperable platform, preventing full-chain integration, content creation rights confirmation, and accommodation of all resources and services. Current efforts remain independent and fragmented projects—the most direct problem facing libraries in metaverse practice [17].

3.2.2 Need for Enhanced Professional Competencies

Metaverse libraries bring entirely new digital working environments, imposing new requirements on librarians' and users' digital literacy and information skills.

Librarians need digital, networked, and intelligent service capabilities for the new era, along with familiarity with virtual scenarios and practical operation of related applications. Users need to understand metaverse library projects and possess the ability to operate various applications properly. Currently, librarians' understanding and application of metaverse technologies remain in the learning stage, and library users also need to strengthen their practical operation abilities. Both groups' competencies regarding metaverse libraries require improvement.

3.2.3 Urgent Need for Technical Risk Prevention

Taking Non-Fungible Tokens (NFTs) as an example, their main application scenarios in libraries include collections, exhibitions, cultural creativity, and services—all carrying potential risks. At the economic level, NFTs harbor huge bubbles and risks of illegal financial transactions. At the technical level, NFTs exhibit instability, with assets potentially being lost. At the ethical level, driven by profit, the authenticity of NFT collections becomes difficult to verify. At the literature copyright level, NFT copyright ownership remains unclear for both paper and digital documents. All these represent merely the tip of the risk iceberg.

4 Future Considerations for Metaverse-Library Integration

Metaverse applications in gaming, finance, education, cultural tourism, and other fields remain in their infancy. Library professionals need to prepare in advance, considering how to shape new scenarios and provide new momentum to better fulfill library functions within the metaverse vision. In the context of metaverse-library integration, this paper focuses on future development across eight aspects: conceptual leadership, institutional planning, collaborative development and sharing, talent cultivation, risk prevention, cultural inheritance, social education, and ethics. It is hoped that colleagues in the field can advance metaverse-library integration conditionally and step-by-step according to their own development circumstances.

4.1 Conceptual Leadership: Embracing the Metaverse Library Track

Metaverse discourse remains varied, with people exploring, observing, questioning, or criticizing. However, the metaverse is already around us, and various fields will sooner or later enter the metaverse track. As a frontier for information technology innovation and application research, libraries must seize opportunities proactively, actively engaging with new industrial revolutions and technological industries to integrate new resources, shape new business forms, and launch new services. On one hand, libraries must break through their development bottlenecks, using metaverse key technologies to advance digital, intelligent, and smart transformation, truly bringing characters written in ancient books to life, and achieving intelligent scenarios and immersive virtual services. On

the other hand, libraries uphold an open and inclusive development philosophy. Metaverse-library integration advances libraries toward smart libraries, promoting bold experiments between "virtual" and "real" to form virtual-physical interaction in resources and services—representing the future direction of library work and injecting new momentum into library development.

4.2 Institutional Planning: Constructing Metaverse Library Standards

Focusing on the new development pattern of metaverse libraries, top-level design should be completed, actively promoting the development of metaverse library-related projects and continuously improving institutional construction in practice to support high-quality development through standardization and normalization. On one hand, library administrative departments, professional associations, and social organizations should formulate basic standards, technical rules, and service specifications for metaverse library construction, operation, and services in reality, establishing full-chain regulatory mechanisms and strengthening supervision capabilities. On the other hand, libraries must dare to "cross the river without stones," forming norms and systems through practical exploration and drawing on achievements. Libraries should establish a complete set of metaverse rules and regulations to promote and advance the metaverse library form toward smart libraries [18].

4.3 Collaborative Development and Sharing: Building Metaverse Library Platforms

Metaverse library platform construction is a systematic project requiring the implementation of development concepts featuring "innovation, coordination, green development, openness, and sharing" [19]. Through unified architectural design based on common needs, comprehensive solutions should be completed that address everything from infrastructure to frameworks, content to interaction, and narrative to experience. This will achieve full-chain integration, content creation rights confirmation, and accommodation of resources and services, deepening cooperation within libraries, across the industry, and across sectors to leverage the advantages of collaborative development and sharing platforms.

4.4 Talent Cultivation: Enhancing Metaverse Librarian Competencies

Library services are founded on talent, and having a professional team provides a strong guarantee for quality services. Metaverse libraries bring entirely new digital working environments, imposing new requirements on librarians' and users' digital literacy and information skills. Therefore, cultivating professional talent must proceed from reality, considering both internal and external library aspects through multiple approaches. First, establish talent delivery mechanisms to recruit or introduce relevant professionals according to metaverse library construction needs. Second, strengthen team cultivation by improving

the overall competencies of librarians and users through mentorship, training, and exchanges.

4.5 Risk Prevention: Avoiding Technology Introduction Risks in Metaverse Libraries

New technology introduction brings both opportunities and challenges to metaverse libraries. Grasping opportunities and meeting challenges requires prevention at both institutional and technical levels. At the institutional level, libraries should refer to the *14th Five-Year National Informatization Plan* issued by the Central Cyberspace Affairs Commission in 2021, formulating practical regulations according to industry standards to avoid technology introduction risks. At the technical level, libraries must possess a professional talent team to exercise strict control before, during, and after technology implementation, preventing risks in literature copyright ownership and illegal financial transactions.

4.6 Cultural Inheritance: Promoting Innovation with Integrity in Metaverse Libraries

As cultural dissemination institutions, libraries possess rich resources including ancient books, local chronicles, film archives, historical images, and ethnic folk literature and art that can stimulate knowledge vitality and prosper socialist culture. Metaverse libraries generate metaverse tokens through digital collections, applying blockchain, virtual-physical interaction, big data, and artificial intelligence technologies to the production, circulation, rights confirmation, transactions, payments, and copyrights of library cultural digital assets. This realizes open sharing of collection resources and promotes new forms of cultural inheritance. The metaverse itself upholds an open and inclusive development philosophy, supporting open sharing and user-generated content. Users can create knowledge on metaverse library platforms, pioneering library knowledge innovation and promoting libraries' important role in modernizing the national cultural governance system and capabilities, thereby advancing innovation with integrity in metaverse libraries.

4.7 Social Education: Expanding Metaverse Library Function Development

Public libraries bear the important function of improving universal information literacy and skills. Broadly speaking, they can expand social education models and enhance digital literacy education; narrowly speaking, they can provide educational assistance to vulnerable groups and ensure educational equity. Metaverse library social education forms are gradually developing toward immersive and real-time directions. Our goal is to enable users to truly experience "zero-delay" operations within the library's virtual education space. From a temporal dimension, knowledge services will not vary due to differences in population density. Through scenario-based storage and data model construction, metaverse libraries enable all users to enjoy real-time educational services, achieving

comprehensive integrated development. From a spatial dimension, users from different regions can participate in library educational activities, facilitating anytime, anywhere access to social education services provided by libraries.

4.8 Ethics and Morality: Reshaping Civilization in Metaverse Libraries

Metaverse libraries will create a virtual form where users enter metaverse spaces and scenarios with digital identities, facing challenges at the boundaries of finite versus infinite, order versus resources, and ethics versus civilization [20]. First, libraries must follow relevant systems to ensure user information security and develop metaverse projects prudently, while also judging whether to launch metaverse projects based on actual development conditions. Second, metaverse-library integration must comply with public order, good customs, and ethical standards, uphold public welfare attributes, and adhere to the original mission of "inheriting civilization and serving society." Finally, user behavior in metaverse library environments must be regulated, requiring the shaping of virtual civilization in the metaverse to promote healthy interaction and development between virtual and real civilizations.

Libraries stand at a critical juncture of changing times. Metaverse-library integration manifests in two ways: on one hand, the metaverse serves as an underlying tool for libraries to achieve digital resource transformation, service virtualization, and spatial scenarization; on the other hand, libraries serve as production materials for metaverse development. Their integration will create infinite possibilities. Libraries are growing organisms, and library professionals must seize opportunities and prepare in advance. Against the backdrop of the digital intelligence era, shaping metaverse libraries as an opportunity will drive library digital transformation, virtualization upgrades, and smart development.

References [1] Zhao Guodong, Yi Huanhuan, Xu Yuanzhong. Metaverse[M]. Beijing: China Translation Publishing House, 2021:3-4. [2] Davis A, Murphy J, Owens D, et al. Avatars, people, and virtual worlds: Foundations for research in metaverses[J]. Journal of the Association for Information Systems, 2009(2):90-117. [3] Guo Yajun, Li Shuai, Ma Huifang, et al. Library as Education: Social Education in Public Libraries from the Metaverse Perspective[J]. Library Tribune, 2022(5):42-51. [4] Yang Xinya, Qian Guofu, Chang Tingting, et al. Is the Metaverse the Future of Libraries?[J]. Library Tribune, 2021(12):35-44. [5] Xiang Anling, Gao Shuang, Peng Yingtong, et al. Knowledge Reorganization and Scenario Reconstruction: The Metaverse for Digital Resource Management[J]. Documentation, Information & Knowledge, 2022(1):30-38. [6] Wu Jiang, Cao Zhe, Chen Pei, et al. User Information Behavior from the Metaverse Perspective: Framework and Prospects[J]. Journal of Information Resources Management, 2022(1):4-20. [7] Xu Xin, Yi Yaqi, Wang Xiaoyun. The Current "Seven Deadly Sins" of the Metaverse: From Industrial Risk Amplifier to New Information Management Landscape[J]. Library Tribune, 2022(1):38-44. [8] Hunan Library. Keeping Pace with Technology Frontiers—Hunan Library

Holds “Metaverse” Themed Sharing and Exchange Meeting[EB/OL].[2023-04-10].http://whhlyt.hunan.gov.cn/whhlyt/news/gzdt/202111/t20211109_{21027635}.html. [9] Library Society of China. First National Smart Library Construction Joint Meeting Held in Beijing[EB/OL].[2023-04-10].http://www.chnlib.com/News/2022-01/1326261.html [10] China Copyright Protection Center. The 18th Shenzhen Cultural Fair Metaverse Copyright Forum[EB/OL].[2023-04-10].http://www.ncac.gov.cn/chinacopyright/contents/12227/357168.shtml [11] Zhang Kun, Zha Xianjin. Research on the Development History and Construction Strategies of Smart Libraries in China[J]. Journal of the National Library of China, 2021(2):80-89. [12] Zhao Zhiyun, Lin Zijie. The Metaverse and Smart Libraries: A New Path for Technology-Enabled Culture[J]. Documentation, Information & Knowledge, 2022(6):6-16. [13] Zhang Xingwang, Bi Yuxin, Zheng Cong. Integration of Library and Metaverse Theory: Connotation Characteristics, System Structure, and Development Trends[J]. Library & Information, 2021(6):81-89. [14] Dong Tongqiang, Wang Mei. Integration of Virtual and Real: Future Ecological Vision of Smart Libraries from the Metaverse Perspective[J]. Library Science Research, 2022(5):20-25. [15] Liu Wei, Zhu Rui, Shan Rongrong. Library Metaverse: What, Why, and How?[J]. Library Tribune, 2022(7):7-17. [16] Yang Xinya, Tu Jiaqi. Library Virtual Services from the Metaverse Perspective[J]. Library Tribune, 2022(7):18-24. [17] Yan Dan, Xu Yaping, Yu Chenlin, et al. Theoretical Progress, Practical Issues, and Future Prospects of Metaverse Libraries[J]. Library Journal, 2023(2):4-12,21. [18] Zhang Lei. Metaverse Library: Theoretical Research, Service Scenarios, and Development Considerations[J]. Library Science Research, 2022(6):9-17. [19] Wu Yingchun, Liang Wenwen, Zhou Lijin. Analysis of Data Open Sharing in Public Libraries[J]. Journal of Academic Library and Information Science, 2023(1):82-87. [20] Zhi Yingying. Metaverse Library: A Promising Alternative Civilization Space[J]. Library Theory and Practice, 2022(5):71-76,84.

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