Integration of the Metaverse and Libraries: Evolution, Technological Pathways, Applications, and Future Perspectives (Postprint)

Authors: Wu Yingchun

Date: 2024-06-13T00:00:00+00:00

Abstract

This article examines the evolutionary trajectories of the metaverse and libraries, summarizing the fundamental relationship underlying their integration; constructs a technical pathway framework for metaverse libraries, elaborating on the key technologies enabling their convergence; delineates the challenges encountered in this integration through an analysis of metaverse application practices in public and academic libraries; and finally proposes development recommendations for metaverse library integration across eight dimensions: conceptual leadership, institutional planning, collaborative construction and sharing, talent cultivation, risk prevention, cultural inheritance, social education, and ethical considerations.

Full Text

Integration of Metaverse and Libraries: Evolution, Technical Path, Application Practice, and Future Considerations

Wu Yingchun
Nanjing Library, Nanjing, China

Abstract: This paper examines the integration of metaverse and libraries by first tracing their respective evolutionary trajectories to identify the fundamental relationship between them. It constructs a technical path framework for metaverse libraries and elaborates on the key enabling technologies. The challenges of integration are described through application practices in public and university libraries. Finally, development recommendations are proposed across eight dimensions: conceptual leadership, institutional planning, collaborative construction and sharing, talent cultivation, risk prevention, cultural inheritance, social education, and ethical considerations.

Keywords: Metaverse; Libraries; Integration; Intellectualization

Funding: This research is supported by the Jiangsu Library Society Project "Integration of Metaverse and Libraries: Technical Path and Future Development" (22YB022), the China Library Society Project "Standardization Research on Deep Integration of Library Cultural Walk-through and Reading Promotion under Digital Dissemination" (22YB051), and the Jiangsu Library Society Reading Promotion Project "Analysis of Role Positioning, Competency, and Service Path of Data Librarians in Public Libraries in the Intelligent Era" (YD2022B105).

1. Evolution of Metaverse-Library Integration

Both metaverse and libraries have undergone distinct evolutionary processes that reveal their fundamental interrelationship. Libraries have progressed through three main stages: (1) the pre-network era of physical libraries centered on print collections, (2) the digital library phase characterized by digital resource construction and information systems (2000-2015), and (3) the smart library phase focused on comprehensive intelligent transformation and knowledge services (2015-present). The metaverse has similarly evolved through three phases: (1) the classical metaverse represented by artistic forms such as Petrarch's works, (2) the game-based metaverse exemplified by science fiction and electronic games, and (3) the modern metaverse marked by milestone events like Linden Lab's launch of the Open3D-based virtual world in 2003, Mojang's sandbox game in 2009, and Facebook's Horizon platform in 2019.

Key events linking metaverse and libraries include: in 2006, the Alliance Library System (ALS) collaborated with Online Programming for All Libraries (OPAL) to explore library services in virtual worlds; in 2007, Hong Kong Polytechnic University's Pao Yue-kong Library became China's first virtual library; and in 2021, the metaverse concept gained mainstream attention when Roblox was listed on the NYSE and Facebook rebranded as Meta. China has since established the China Mobile Communications Federation Metaverse Industry Committee and the Metaverse and Virtual-Reality Interaction Joint Research Institute in Shanghai.

The basic relationship between metaverse and libraries manifests in several ways. Both are continuously evolving organisms with similar developmental trajectories, technological foundations, and cumulative processes. Libraries serve as essential information and knowledge hubs for the metaverse, while metaverse technologies offer libraries new opportunities for transformation toward smart libraries, enabling immersive three-dimensional services that transition from virtual-physical separation to integration and from single-plane to multi-sensory experiences.

[Figure 1: see original paper] The relationship between metaverse and libraries

2. Technical Path for Metaverse-Library Integration

2.1 Technical Path Framework

The technical path framework for metaverse libraries comprises three layers: underlying technical support, front-end device platforms, and scene content. The underlying support includes infrastructure (communication and computing facilities) and key technologies. Front-end device platforms encompass somatosensory, scene, and neural devices that prepare for scene content implementation. The scene content layer includes both operating environments (legal systems and ethical frameworks) and application scenarios (authentication transactions, embodied interaction, reading promotion, and cultural innovation).

[Figure 2: see original paper] Technical path framework for metaverse libraries

2.2 Key Enabling Technologies

Blockchain Technology: Blockchain, together with Non-Fungible Token (NFT) and Non-Fungible Rights (NFR) systems, provides technical support for compliant operation of digital asset transactions in metaverse libraries. Its interoperability, tradability, and immutability facilitate digital resource circulation, sharing, and copyright certification.

Artificial Intelligence: AI serves as the generative logic enabling language recognition, natural language processing, and intelligent management throughout the entire chain from knowledge generation to dissemination and acquisition.

Network Communication Technology (5G/6G): This solves communication barriers by enabling high-speed connectivity, universal interconnection, and resource sharing required by metaverse applications.

Big Data Technology: As a cultural empowerment technology, big data enables intelligent upgrades of library hardware and software, facilitates development and sharing of cultural data platforms, and creates new information integration modalities across physical, digital twin, and virtual worlds.

Virtual-Actual Interaction Technology: This includes Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and Extended Reality (XR) technologies that create immersive environments for real-time user-information interaction in the metaverse.

3. Application Practice of Metaverse-Library Integration

Metaverse applications in Chinese libraries remain exploratory, primarily concentrated in public and university libraries.

3.1 Public Library Practice

The Shanghai Library exemplifies metaverse application in public libraries. Since commencing construction of its East Branch in 2018, it has planned multiple metaverse application projects to advance from digital to smart library services. These projects initially lacked metaverse-specific names but gradually became associated with the concept through development. Key applications include NFT-based collections, cultural creativity, and service innovations. However, challenges persist: staff and users lack adequate digital literacy; technical risks require prevention; and potential issues include illegal financial transactions, asset loss, and authenticity verification for both physical and digital collections.

3.2 University Library Practice

Chongqing University Library represents a leading case in university libraries, establishing virtual service application projects including virtual exhibition halls and virtual tours. The library has launched multiple metaverse projects to meet reader needs, though applications remain nascent. Major challenges include insufficient staff understanding of metaverse technologies, fragmented project development without unified architecture, and failure to address digital resource rights confirmation issues.

Common difficulties across both library types include: (1) competency gaps among librarians and users in digital skills and metaverse applications; (2) technical risks requiring institutional and technological safeguards; and (3) lack of unified platforms connecting disparate projects into cohesive systems.

---

4. Future Considerations for Metaverse-Library Integration

4.1 Conceptual Leadership: Embracing the Metaverse Library Track

Despite varied discourse on the metaverse, its arrival is undeniable. Libraries must seize the initiative as frontiers of technological innovation. With an open and inclusive development philosophy, libraries should leverage metaverse technologies to advance digital and intelligent transformation, enabling immersive virtual services and bringing ancient texts to life.

4.2 Institutional Planning: Establishing Metaverse Library Standards

Regulatory bodies, professional associations, and social organizations must formulate operational standards, technical rules, and norms for metaverse libraries. Top-level design should create comprehensive regulatory mechanisms and full-chain supervision. Libraries should develop practical regulations referencing the

2021 National Informatization Plan to standardize development and avoid risks in copyright, illegal transactions, and other areas.

4.3 Collaborative Construction: Building Metaverse Library Platforms

Platform construction requires systematic engineering through unified architectural design that addresses everything from infrastructure to frameworks, content to interaction, and storytelling to experience. Libraries should promote internal collaboration, inter-library cooperation, and cross-sector partnerships to achieve resource and service integration, content creation rights confirmation, and platform-wide interconnectivity.

4.4 Talent Cultivation: Enhancing Librarian Competencies

Metaverse libraries demand new digital competencies from both staff and users. Libraries should: (1) establish talent pipelines by recruiting specialized professionals, and (2) enhance overall staff and user competencies through training and exchange programs to develop digital literacy and intelligent service capabilities.

4.5 Risk Prevention: Mitigating Technology Introduction Risks

New technologies introduce both opportunities and risks. Prevention requires: (1) institutional measures including practical regulations and industry-standard compliance, and (2) technical measures such as strict controls throughout technology implementation to prevent copyright, security, and financial risks.

4.6 Cultural Inheritance: Promoting Innovation in Metaverse Libraries

As cultural institutions with rich collections of ancient texts and folk works, libraries can leverage metaverse technologies to activate knowledge vitality and prosper socialist culture. Blockchain, AI, big data, and virtual-actual interaction technologies enable digital asset production, resource sharing, and new forms of cultural inheritance while supporting user-generated content.

4.7 Social Education: Expanding Library Functions

Metaverse libraries can revolutionize social education by providing immersive, real-time educational services that transcend temporal and spatial limitations. They can expand education models, improve digital literacy training quality, assist disadvantaged groups, and ensure educational equity through virtual educational spaces accessible anytime, anywhere.

4.8 Ethics and Morality: Reshaping Virtual Civilization

Metaverse libraries create virtual environments that challenge boundaries of order, resources, ethics, and civilization. Development must comply with public order, ethical standards, and legal regulations. Libraries should protect user information security, regulate user behavior in virtual environments, and promote healthy interaction between virtual and real-world civilizations.

---

5. Conclusion

Libraries stand at a critical juncture of transformation. The metaverse offers a foundation for digitizing resources, virtualizing services, and spatializing scenarios. While integration creates infinite possibilities, it also presents practical difficulties requiring industry-wide and academic collaboration. As living organisms, libraries must embrace this opportunity to achieve digital transformation, virtual upgrading, and intelligent development in the digital intelligence era.

References

[1] Davis M, Owens D. Avatars, people, and virtual worlds: foundations for research in metaverses[J]. Journal of the Association for Information Systems, 2009(2): 90-117.

[2] Zhao Guodong, Yi Huanhuan, Xu Yuanzhong. Metaverse[M]. China Translation & Publishing House, 2021: 3-4.

[3] Wu Jiang, He Chaocheng, Li Shanshan. Social Education in Public Libraries from the Perspective of the Metaverse[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 Changlong, et al. Knowledge Reorganization and Scene Reconstruction: Metaverse for Digital Resource Management[J]. Document, Information & Knowledge, 2022(1): 30-38.

[6] Wu Jiang, He Chaocheng, Li Shanshan. User Information Behavior from the Perspective of the Metaverse[J]. Journal of Information Resources Management, 2022(1): 4-20.

[7] Xu Xin, Yi Yaqi, Wang Xiaoyun. The Present Metaverse: From Industrial Risk Amplifier to New Landscape of Information Management[J]. Library Tribune, 2022(1): 38-44.

[8] Hunan Library. Keeping Pace with Technology Frontier: 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. The First Meeting of the National Smart Library Construction Joint Conference Held in Beijing[EB/OL]. [2023-04-10]. http://www.lsc.org.cn/cns/contents/1186/15409.html.

[10] National Copyright Administration of China. The 18th Shenzhen Cultural Fair Metaverse Copyright Protection Forum Successfully Held[EB/OL]. [2023-04-10]. http://www.ncac.gov.cn/chinacopyright/contents/12227/357168.shtml.

[11] Wu Jianzhong. Research on the Development History and Construction Strategy of Smart Libraries in China[J]. Journal of the National Library of China, 2021(2): 80-89.

[12] Huang Chen. Metaverse and Smart Libraries: A New Path for Technology Empowering Culture[J]. Document, Information & Knowledge, 2022(6): 6-16.

[13] Wu Jiang, He Chaocheng, Li Shanshan. Libraries and the Metaverse: Theoretical Integration, Architecture, and Development Trends[J]. Library & Information, 2021(6): 81-89.

[14] Yang Xinya, Qian Guofu, Chang Tingting, et al. Future Ecology of Smart Libraries from the Metaverse Perspective[J]. Library Science Research, 2022(5): 20-25.

[15] Xiang Anling, Gao Shuang, Peng Changlong, et al. Library Metaverse: Why and How[J]. Library Tribune, 2022(7): 7-17.

[16] Wu Jiang, He Chaocheng, Li Shanshan. Library Virtual Services from the Perspective of the Metaverse[J]. Library Tribune, 2022(7): 18-24.

[17] Xu Xin, Yi Yaqi, Wang Xiaoyun. Theoretical Progress, Service Scenarios, and Development Considerations of Metaverse Libraries[J]. Library Science Research, 2022(6): 9-17.

[18] Wu Jiang, He Chaocheng, Li Shanshan. Metaverse Libraries: A Promising Alternative Civilization Space[J]. Library Tribune, 2022(5): 71-76, 84.

[19] Yang Xinya, Qian Guofu, Chang Tingting, et al. Metaverse Libraries: Issues and Future Prospects[J]. Library Journal, 2023(2): 4-12, 21.

[20] Xiang Anling, Gao Shuang, Peng Changlong, et al. Metaverse Libraries: A Promising Alternative Civilization Space[J]. Library Tribune, 2022(5): 71-76, 84.

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