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A Literature Review of Research on Meta-universe Libraries

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Abstract

As an emerging research field, Meta-universe Library is attracting wide attention in the library field. In this study, we systematically combed the relevant literature of the Meta-universe library in CNKI database, and carried out in-depth analysis from three dimensions of conceptual evolution, development stage and application practice. Focus on analyzing the relationship between meta-universe library and intelligent library, analyzing the technical architecture of meta-universe library and the development stage, and the problems in specific practice from different application scenarios. Future research should focus on the system construction, service mode innovation, professional role remodeling, technical ethics and other directions of the universe library, so as to promote the sustainable development of this field. This study provides new ideas and reference framework for the theoretical exploration and practical application of meta-universe library.

Keywords

Intelligent library, Meta-universe, Third world, Data security

1. Introduction

The national 14th Five-Year Plan, officially released in March 2021, lists new-generation information technologies such as big data, cloud computing and blockchain as key industries in the digital economy. Yuan universe involves the information technology and application and digital economy development strategy, through virtual reality (VR), augmented reality (AR), mixed reality (MR) technology, build a digital world, is changing people's way of life and social structure, at the same time, also will bring new opportunities and challenges for the digital transformation of the library. On March 21,2023, the world's first digital library with Meta-universe characteristics — "Lingang Digital Technology Library" was officially opened to the public, creating an online and offline immersive interactive reading experience [1] for users.

The library not only undertakes the function of social "memory", but also as an important cultural institution of the society, the meta-universe will completely

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change the survival and service ecology of libraries [2]. The academic circle will actively carry out relevant research and practice around the meta-universe. Many scholars integrate the meta-universe with the library at the theoretical level, and explore the application of the meta-universe in the library space, resources and service mode. However, few scholars explore the application status of meta-cosmic basic technology in libraries from the perspective of coordination. This paper aims to review the applied research literature of meta-universe and library to fully understand the hot spots and trends in the research field. By collecting relevant journal papers in recent years, the relationship between meta-universe and library is discussed, and the relevant research results are summarized and summarized. This paper summarizes the concept, technology and practical application of meta-universe and library, and analyzes the hot research spot and the future development trend. Finally, directions and suggestions for further research are proposed to provide reference for the future development of the universe and library applications.

2. Data source

In this study, CNKI was used as the source of domestic literature data. In order to improve the detection rate and accuracy rate, 153 relevant Chinese documents were retrieved by using "SU = meta-universe * Library". Using the "Meta-universe Library", "Second Life", as the key word, "TS=Meta-universe and TS=library" and "TS = (" Meta-universe "OR" virtual world "OR" virtual reality ") AND TS = (" library "OR" libraries ")" are the search documents in the Web of Science core collection database, After removing the irrelevant and duplicate literature, Finally, 73 Chinese documents and 11 foreign language related documents were analyzed to complete the literature review.

3. Concept of a Meta-universe Library

3.1. Meta universe

At present, the industry and academia have not yet formed a unified conclusion on the concept of the meta-universe. Meta-universe originated from the concept of "Metaverse" in 1992 Snow Crash by Neal Stephenson, a real human living with virtual people in the virtual space [3] through VR equipment. Dionisio [4] defines the meta-universe as a fully immersive three-dimensional digital environment. Ball [5] describes the meta-universe as a 3D virtual world, where people are interrelated, have their own exclusive digital identities, and contain developed economic systems and content creation systems. Chinese scholars Yang Xinya [6] and others believe that it integrates VR (virtual reality), AR (augmented reality), blockchain, artificial intelligence and other information technologies to build a

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virtual society with immersive experience for users, with the characteristics of independent economic system, growing civilization system and substantive content production system. Zhao Xing [7] and other scholars put forward two basic principles of the meta-universe, the principle of virtual and real interaction and the principle of technology interconnection, emphasizing the interconnection between real and virtual interaction and technology. Wujiang [8] believes that the meta-universe is a three-way world digital society integrating virtual and real. It is built by digital technology, and human beings participate in it as a digital identity. Zhou Wenjie [9] reviews the development of human information communication, which defines the meta-universe as a space based on huge resource space that immerse users in and participates in content generation and editing. Interactive living space. The 2020-2021 Space Development Research Report [10] proposes that the universe is a new Internet application and social form that integrates virtual and reality, and is a mirror image of the real world. Citizens can interact with virtual people for content production and world editing. Zhou Xin, Wang Haiying [11] and others, combined with the description of domestic and foreign scholars, define the Meta-universe is a deeply immersive, highly free and closely related virtual world created on the basis of the integrated application of cloud computing, Internet of Things, communication technology, blockchain, virtual reality and other digital, network and intelligent technologies.

The philosophy can be introduced from the theory of three worlds in the universe, and world 1 is the physical world, including matter and energy, and world 2 is the world of subjective knowledge, including state of consciousness and subjective experience; world 3 is the world of objective knowledge, including knowledge unit, logical framework and theoretical system recorded and stored by various carriers. Liu Wei, Zhu Rui and other scholars pointed out that the "third world" imagined by the philosopher Popper in the 1970s, also known as the "knowledge world", is the meta-universe [13] outside the material world and the spiritual world.

So far, the concept of the meta-universe has not yet formed a unified definition in all circles. To sum up, the main feature of the meta-universe is that users have the virtual avatar in the meta-universe, producing information and value in immersive experience, interaction and creation. The economic system and society of the meta-universe will be closely connected with the real world and maintain mobile. Based on the three-world theory, this paper defines the meta-universe as the digital third world. It is a virtual environment composed of computers and other digital devices and contains a large number of digital content and virtual elements, in which users can enter for immersive exploration and interaction.

3.2. Meta-universe Library

Tang Shang [14] believes that the library meta-universe is a new library form constructed based on metacheology technology.Library meta-universe, as the goal and end point of the integration of library and meta-universe theory, is not only the

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technical upgrade, but also the innovation of library service model and user experience. To sum up, the meta-universe library is the deep integration of the physical world and the digital world to realize the intelligent growth of the library itself. Improve the collaborative configuration and information interaction of all physical resources related to library data resources (such as buildings, bookshelves, network equipment, office facilities, water, electricity and air conditioning, etc.), and realize the closed-loop enabling system of library physical resources and data resources to gradually build a library meta-universe network ecosystem with virtual-real integration, real-time mapping and collaborative interaction.

4. Stages of Development of the Meta-universe Library

4.1. Technical Architecture of the Meta-universe Library

Guo Yajun [15] divided the technology system of the yuan-universe library into mapping, access, construction and application categories. Li Hongchen [16] expands the metacom library architecture from the physical layer, technology layer and functional layer. The physical layer is the equipment basis for the immersive communication of the meta-universe library, and the technical layer is the technical basis for the immersive interaction of the meta-universe library. The functional layer gives more functions to make users more immersive in library activities. Li Mo [17] looks at the service mode of the intelligent library from the perspective of the universe, and constructs the technical framework of the library meta-universe system from six levels: physical layer, software layer, data layer, rule layer, application layer and interaction layer. Xin Haixia [18], based on the value level model, divides the technical architecture of meta-universe library into infrastructure layer, human-computer interaction layer, decentralization layer, spatial computing layer, creator economic layer, discovery layer and experience layer. Zhang Xingwang believes that the technical architecture can be divided into four levels: physical fusion layer, model fusion layer, data fusion layer and service fusion layer. The physical fusion layer is the physical foundation, the model fusion layer is the virtual mapping of physical entities, and the data fusion layer is the constructed big data system, and the service fusion layer refers to the business logic of the meta-universe library. Linmei [19] divides the technical system into network environment layer, virtual and real interaction layer, data processing layer, identity authentication layer and content production layer. Dong Tongqiang [20] and other scholars analyze the field structure of the library meta-universe service system from the perspective of technology empowerment, including physical layer, resource layer, analysis layer and interaction layer. Bai Zhongxian [21] and other scholars define the learning space of intelligent library as a combination of physical space, virtual space and meta-universe space, consisting of physical layer, software layer and technology layer. Data layer, application layer, interaction layer, scenario

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layer, rule layer, development layer. The meta-cosmic space transfers the user behavior and cognitive activities in the offline physical space to the online digital space through digital and intelligent technology, and realizes the interaction and integration of virtual and real, thus forming the "third type of" living space " [22] of the concrete intelligent library. Wang Xiaoyue [23] established augmented reality system framework is mainly based on data environment layer, physical perception layer, human-computer interaction layer, intelligent control layer and augmented reality application layer, specific divided into acquisition equipment module, identification code recognition module, image recognition module, image tracking module, multi-layer image dynamic fusion module, augmented reality space building module and environment rendering module.

Based on previous research, the technical architecture of meta-universe library can be divided from different angles. For example, technology can be divided into application layer, service layer, data layer and security layer based on function, or technologies can be divided into physical layer, technology layer and functional layer from the perspective of realizing meta-universe library immersive interaction and participating in activities. The hierarchy of technical architecture includes infrastructure layer, interactive link layer, human-machine interface layer, personal experience layer, human-computer interaction layer, decentralization layer, spatial computing layer, creator economic layer, discovery layer, experience layer, etc.The technical framework of the meta-universe library is a multi-level and multi-dimensional system. The infrastructure layer serves as the primary technical support, providing compute, storage, and networking capabilities. Data resource layer is the integration and management of all data resources. The interaction layer ensures the user's interactive experience by technology. The decentralized layer realizes the secure sharing and decentralized management of resources through technologies such as blockchain to ensure the security of user data. The content creation layer is responsible for the content generation and management of the meta-Universe Library. The organic combination of platform and application scenarios enables users to experience novel digital technologies and virtual simulation systems in all aspects. The combination of different levels of the technical architecture of the meta-universe Library achieves virtual-real integration, real-time interaction and intelligent services, providing users with a new reading and learning experience.

4.2. Smart Library and Meta-universe Library

The library industry has been evolving towards the direction of digitalization and virtualization, and has put forward the concept of digital library, virtual library and smart library. In 2003, M. Aiola of the University Library of Oulu in Finland proposed the term smart library [24], believing that smart library is not limited by time and space, and the core technology groups such as virtual technology and intelligent technology are the basic [25] for its generation and development. In

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2010, Yan Dong [26] proposed that smart library is a more intelligent method, by using the new generation of information technology to change the way users and library system information resources interact, so as to realize the library mode of intelligent service and management. This is the first time that the concept of smart library has appeared in China. Wang Xiaoyue [27] believes that the form of the universal library is the necessary stage and inevitable product of the development of the intelligent library. Chen Dingquan [28] and other scholars believe that the metalibrary is a new people-oriented library applied in the intelligent Meta-universe ecology of the library, with the purpose of real space and virtual space, real resources and virtual resources, and real natural persons and virtual digital people. Zhang Qinglai [29] proposed the expression form of intelligent library, which is very suitable for information resource organization and knowledge service provision in the meta-universe. Chujiewang [30] and other scholars believe that the intelligent library is the final form of the library by using the underlying technology such as expanding reality, blockchain and other technologies to realize the intelligent service, and is the final form of the development of the smart library.

It can be said that the library in the meta-universe should be a combination of virtual and real existence that can provide various services with digital split body or intelligent robots, and is a kind of virtual intelligent library. Both meta-universe library and intelligent library are important forms in the development of digital and intelligent library, but there are some differences and connections in their goals, technical realization and application scenarios. The smart library is the foundation of the meta-universe library. The meta-universe library upgrades the existing technology of the smart library, expands the service boundary of the smart library through the virtual space, and provides a richer user experience. The smart library focuses on the intelligent management of physical libraries and optimizes resource management and service efficiency through technical means. Meta-universe Library focuses on the construction of virtual library and provides immersive and interactive user experience through virtual and real fusion technology. With the further development of technology, the two will be deeply integrated to jointly promote the digital transformation and innovative development of libraries.

4.3. Future development of the Meta-universe Library

Zhang Xingwang [31] and other scholars put forward that libraries and the meta-universe have a common technology-driven evolution process, and the digital intelligent services in libraries have a high degree of fit with the meta-universe. Library compared to other areas and the integration of the universe development more superiority, the library for the development of the universe information and knowledge resources, at the same time, the universe users need more library virtual knowledge services, let the library have more business scenarios and user groups, brought new opportunities for development to the library. Teng Lei, CIO of ARK innovation consulting company, divided the universe into three stages: digital twin

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/ digital native, virtual and real to virtual [32]. Zhang Qilin [33] the three image types of the library in the universe, hall (small universe), spectacle (large and medium-sized universe), companion (giant universe). Based on the way the real self and the spiritual self exist, [34] et al. divided the Meta-universe space into four types: mirror twin, enhanced symbiosis, virtual native, and alien regeneration. Li Hongchen [35] and other scholars divided the process into four stages: enhanced symbiosis (reality superimposed virtual), mirror twin (based on reality mapping virtual), virtual native (virtual world where reality does not exist), and alien symbiosis (real activities are projected to the virtual world).

Human beings gradually step into the ternary world [36] composed of the physical world, human social space and digital virtual space. Rao Quan [37] believes that the meta-universe is a digital society where people participate in the digital identity based on digital technology. The construction of the metaccosmos will go through three stages: virtual and real twin, virtual and real coexistence, and virtual and real integration. According to the theoretical statement about the field, Zhou Wenjie [38] divided the new knowledge field of the library in the meta-universe into three levels: low autonomous field, high autonomous field and self-oriented field. Zhang Qinglai [39] According to the development stage of the library in the universe and the advance of the universe, that the early yuan-universe library will be an important entrance to the meta-universe and an important pipeline connecting the meta-universe and the real world. In the development and perfection stage of the meta-universe, the library will become the main place for social, economic and cultural entertainment, while the real world only provides the necessary material guarantee conditions. The main task of the library is how to organize the information and knowledge resources in the meta-universe and provide good virtual knowledge services. Library should become a communication pipeline with the real world in the development stage of the universe. In the initial stage of the Meta-universe, each meta-universe is gradually established, and the Meta-universe library should become the traffic port and information channel of each small Meta-universe. Promote the development of the meta-universe, providing pro-universe native services, information and knowledge infrastructure, knowledge exchange media and knowledge exchange communities.

In the stage of infrastructure construction, the meta-universe library mainly realizes the digitalization and intelligent management of the resources in the library. In the initial stage of construction, the library, as the entrance to the meta-universe, provides equal user services to the society, realizes the initial interaction between users and the virtual environment, and gradually establishes the meta-universe system. The development stage is the deep virtualization stage of the meta-universe library, forming a virtual-real integrated library ecology, and the meta-universe library as the communication node of each small meta-universe, establishing a communication bridge. In the forming stage of the meta-universe, the library

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provides the original meta-universe service, supports the social interaction and content co-creation among users, and forms the knowledge exchange medium and knowledge exchange community. In the future development, the library should have the ability of self-learning and optimization, and can dynamically adjust the service mode according to the needs of users, so as to provide more intelligent and personalized user services.

5. Applications scenario of the Meta-universe Library

In addition to retaining the service function, education function, cultural preservation function, cultural entertainment function and think tank function of real library, the Library has added social function, data function and creation function. This paper will discuss the application scenarios of the universal library based on the aspects of "people, fields and things".

5.1. Person

Qi Jing [40] pointed out that in the universe library, there are user immersive panoramic reading, space experience and community interaction, virtual digital human interaction, librarian virtual avatar interaction, etc. Users have their own virtual avatar in the meta-universe, and librarians can also have their own virtual avatar. The virtual digital human in the meta-universe is not only a virtual commercial or artistic image, nor a simple and static physiological simulation of people, but a comprehensive simulation and systematic simulation of human physiological attributes and social attributes by means of various new technologies. It is a social human [41] with social function. Si Li [42] from the perspective of memory medium virtual digital people is divided into real digital people and native digital [43], native digital people is the role of the user control, through programming in the universe, is mainly responsible for intelligent question and answer, virtual explanation, reading promotion, user training, children readers education, special group reader service.

At present, ChatGPT and Deepseek as intelligent AI use cross-mode retrieval technology to construct intelligent retrieval experience, and AIGC application as the "assembly line" of digital content production, realize the transformation of intelligent library to intelligent library, and promote the development of meta-universe library [44]. According to different service scenarios, virtual digital people of borrowing, consulting, accompanying, and education should be built according to different needs to provide resource services, enhance interaction and communication, and assist digital humanities research. Through the tracking of user activities, while ensuring user privacy, it analyzes and processes users' physiological reactions, emotional attitude and other data, implements accurate user portrait, and customized private push.

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The core goal of the Meta-Universe Library is to provide users with more efficient, immersive and personalized services, providing features such as user interaction, personalization and social interaction. Virtual identities and digital dopes provide users with efficient mobility and make it easier to participate in academic conferences or forums. Virtual tour guides can serve users in a full range of services, as a personal assistant to provide navigation and consulting services, for users to answer questions in a timely manner. Users can interact and collaborate with others in the meta-universe Library, creating an open platform for scholars around the world to promote academic exchange and development.

5.2. field of the Meta-universe library

Dong Tiantian [45] based on the library in the 3D game, points out the application of virtual reality technology in the physical library to build the future Meta-universe library scene, from digital twin to virtual native, users can reach at any time. Wang Fengying [46] and others believe that the information resource management mode will develop from the "Tibet-based" closed shelf mode, the limited open mode of "combination of Tibet and use", the "use-oriented" full open mode, and the "three-line collection system" of the intensive library mode to the intelligent library mode. Yang Xinya [47] and other scholars build virtual guide and virtual exhibition hall for Meta-universe Library, creating personal reading space for readers and exclusive personalized bookshelves. Guo Yajun [48] and other scholars proposed to create an immersive virtual education space and an interactive virtual education form, so as to realize the situational and experimental teaching situation. KRK [49] proposed that Meta-universe library can enable users to continuously and steadily participate in the reading therapy scene of virtual library. Guo Yajun [50] proposed to build intelligent maps, VR studios and maker space based on virtual simulation technology, and build VR books to present virtual reading and visual retrieval. Help users to conduct immersive learning and carry out virtual exhibitions and conference scenes, so as to achieve timely communication and sharing anytime and anywhere. The red cycling project launched by Shanghai Library also witnessed the harmonious coexistence of Meta-universe Library, cultural tourism services, and Chinese traditional culture and red resources, creating a distinctive Chinese scene and enabling users to experience Chinese culture in an immersive way.

Meta-universe Library is not limited to the limitations of real venues, on the basis of the virtual and real integration of space construction and scene expansion, meta-universe library for users to create a changeable environment, anytime and anywhere to provide users with the required scenes, through the device can also enter the virtual historical scene, experience the real historical events. The meta-universe library provides users with global resources and services, and users are no longer limited by physical conditions, and can better create in the meta-universe library.

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5.3. Object

In the construction of landmark scenes in libraries, archives and cultural centers, the breakthrough points include the development of cultural digital collections, holographic interaction of archival resources, the shaping of cultural Homo sapiens, etc. Attention should be paid to the data organization of ancient books, knowledge connection, intelligent display and the construction of digital platform. Zhang Yanxi [51] proposed that ancient books use virtual space technology in Meta-universe Library to create virtual ancient books library and bring readers real reading feelings.

Non-Fungible Token (NFT) emphasizes the virtual financial and social attributes of digital assets [52]. Based on the alliance chain, the digital collection strips away the virtual currency and financial attributes of NFT, highlighting its digital collection, virtual-real interaction and digital credential attributes. NFT guarantees that the resources of the meta-universe Library are rightfully owned, tradeable, transferable, and authentic. Such as collection, display, auction, cultural creation and service in the museum's digital collection.

A meta-cosmic library needs to protect not only the physical resources (such as books, digital devices) and virtual resources (digital books) of the library, but also the virtual assets generated by users. Users can buy or rent digital books in the form of NFT in the meta-universe Library, and they can also publish their intellectual achievements to the virtual library. The meta-universe library should attach importance to digital security and user privacy protection. As a social and cultural memory institution and wisdom center, the library needs to build a complete system to protect the digital security of the data generated in the future meta-universe.

5.4. Other scenarios

The universe Library should connect with family education, school education, social education, and reshape the form of social education. Create an intelligent education environment, provide conditions for personalized and customized learning services, comprehensively improve quality-oriented education, and provide a solid guarantee for lifelong education [53]. Fu Aiwen [54] et al. established the internal and external circulation mechanism of multi-layer interaction under the horizon of meta-universe, with the inner circulation formed by the author, reader and the library; the outer circulation is the circulation loop established by the exhibition hall, library, archives and museum. Based on the theory of value co-creation, [55] proposed that the family and society share and activate the collection resources, and create a digital twin home collection book space. Build a Meta-universe node of the home library. Meta-universe Library should pay attention to the exploration of heterogeneous resources, guide the construction of resources, implement lightweight cataloging for future home books, provide a high-speed connection with family books environment, and help users to create personalized home scenes.

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In the continuous development of the meta-universe, the social system gradually improves to form a new meta-universe ecosystem, and libraries should do a good job in interworking with other service institutions. It is deeply integrated with schools, society, families and other fields to build an open, shared and collaborative knowledge ecosystem. Through deep integration with the school education system, it has become an important support platform for teaching, learning and scientific research. At the same time, it is closely integrated with social public services, cultural communication and economic development, and has become an important platform for social knowledge sharing and cultural exchange. Family education should also be taken into account to provide a platform for family members to learn, entertain and interact. The meta-universe Library will serve as a bridge between schools, society and families, promoting cross-domain collaboration and sharing.

6. Discussion

Although the development of the meta-universe library has a broad prospect, it still faces many legal, technical, ethical and social challenges in the process of its advancement. First of all, legal issues have become an important factor restricting its development, such as the limitations of the concept of museum, the lack of fair use of copyright in text and data mining, the lack of flexibility of copyright rules under artificial intelligence technology, the uncertainty of copyright in user-generated content, and the immutability of copyright in smart contracts, etc. These issues need to establish perfect institutional norms.

In the United States, for example, the controlled digital lending model replaces paper through digital dissemination[56], but its restrictions on paper lending have also led to further reflection on digital rights management. In the future, the legal level needs to expand the concept of "museum", not only to cover the traditional physical museum and digital museum, but also to include the digital twin technology and the metacosmic museum under the extended reality technology, in order to meet the needs of technological development .

At the technical level, the implementation of the meta-universe library still faces many obstacles. Currently, there is a lack of highly semantically relevant metadata models that support multiple disciplines, which limits the depth indexing and efficient utilization of resources. To this end, open source distributed infrastructure can be adopted to reduce costs and to build metadata models that support multidisciplinary depth indexing, such as 2D metadata standards, while focusing on the construction of element semantic standards. In addition, data leakage, user privacy protection, and the bias and discriminatory results that AI technology may bring are also technical risks that need to be addressed. As users' search and reading habits change, libraries may face the challenge of losing users unless they can provide innovative services that are significantly different and more valuable

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than traditional services. However, libraries are weak in terms of technology and talents, so that there are few libraries capable of independent research and development, which further aggravates the difficulty of technology application.

The operation and development of the library poses higher challenges to the librarians, and the librarians should improve their own quality but also strengthen the level of cultural knowledge. At the same time, scenario-based 3D / VR resource service system should be built to strengthen the application of virtual digital people, and play the role of virtual digital person in virtual tour, knowledge explanation, reference consultation and VR reading, so as to reduce the burden of librarians. Virtual digital people should optimize and expand their service scope to meet the users' chat and emotional needs. The selection of users, the homogenization of acquiring content and the homogenization of groups in the universal library is easy to form information cocoon in the living space of the universe, which will make it impossible to distinguish the difference between real and virtual world. Virtual digital people replace some existing social division of labor role, may cause new social organization contradictions [57]. Ethically, the boundary between real people and virtual people is blurred, the operation rules are beyond the ethics of human society, and the possible "one-way human beings" [58] can be produced.

The universe library guarantees the balance between the entity and the virtual. The entity is the foundation, and the virtual is the form of expression. Avoid turning from real to virtual. Coordinate the balanced development of reading space and leisure space. To improve the digital tolerance, strengthen the attention to the vulnerable groups, narrow the digital divide, give full play to their own library public functions, train users 'security awareness, librarians' digital security skills training and professional ethics education, improve the user privacy policy, so that everyone can equally enjoy the services of the yuan universe library.In the future, the development of the meta-cosmic library needs systematic optimization at the legal, technical, ethical and social levels. By improving laws and regulations, improving technical capabilities, strengthening personnel training, paying attention to ethical issues, and promoting social inclusion, the library provides users with a new reading and learning experience, while promoting the comprehensive upgrade and innovative development of library services. The meta-universe library is expected to become an intelligent and efficient knowledge service platform integrating virtual reality and open sharing, and realize the third world envisioned by Popper.

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