

Original Article

Research Evolution of Digital Museums in China

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SUMMARY

In this study, a total of 466 articles with the theme of “Digital Museum” published in China National Knowledge Infrastructure (CNKI) from 2000 to 2019 were taken as the research objects. Through the use of CiteSpaceV software developed by Dr. Chaomei Chen and the use of a combination of qualitative and quantitative analysis methods, the development trend of digital museum research, research focus, and the number of published articles were analyzed. It has been found that the development of China’s digital museums has made great progress since the year of 2000, but there were still problems of cooperation among museums, museums and colleges, and the research content focused more on practice rather than theory. In the future, it is necessary to strengthen the connections between different museums, and at the same time deepen the in-depth exploration of the theory of digital museums, enhance their practical leading function, and contribute to the construction of digital museums. ■

KEYWORDS

Digital Museum; Research Review; Museum Construction

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THE digital museum originated in the 1990s. With the rapid development of Internet technology during the past three decades, multimedia and communication based on Internet technology have also undergone tremendous changes. In this context, China's digital museum came into being. These emerging technologies have brought unprecedented changes to the museum, and are quietly changing the direction and trend of the museum's future development, and bringing new development opportunities to the museum that was rarely cared for in the past (1). "Digital museum" refers to the use of digital technology to collect, store and process historical relics in an all-round way, and then to achieve the sharing, efficient use and scientific management of historical relics through network terminals and protocols (2).

After nearly 30 years of development, China's digital museums have realized from basic data collation to dynamic management, from a relatively single management system to a comprehensive museum large-scale protection management system of historical relics, and from exhibition-based multimedia-assisted 2D display to the comprehensive dynamic network construction based on the 3D design. The digitalization and informatization of Chinese museums have undergone many changes such as from simple to complex, from less to more, from static to dynamic, and from inside to outside. At the moment when the museum is changing from a collection type to a participatory type, how should information technology better serve the museum construction, make the museum an indispensable cultural need for public life, and realize the museum mission of "harmonious interaction and shared culture" has been becoming the focus of museums to practice (3).

Therefore, explore the research evolution of digital museums, review and summarize the research on digital museums in China, grasp the research trends of Chinese digital museums for Chinese scholars, understand the current frontier issues of digital museum research in China, and promote the theoretical research and practical development of Chinese museums. This research uses the relevant research literature index materials included in the China National Knowledge Infrastructure (CNKI), with the help of effective measurement methods for obtaining, discovering, and detecting cutting-edge documents. A knowledge visualization method based on knowledge units (CiteSpace) to explore the evolution of China's digital museum research, track do-

mestic digital museum research trends to discover important academic journals, countries, institutions, and authors in this research field, and conduct detailed analysis.

METHODS

Data Sources

In this study, CNKI was used as the search database, and the literature selection period was from 2000 to 2019. Select advanced search, the search method was set to the search method of subject words. Search subject word was: "digital museum"; search logical relationship was "or", search condition was "exact", source category selected "all journals", set "synonym expansion", a total of 466 articles were retrieved. The operation time was March 22, 2019 (Figure 1).

Research Methodology

From the perspective of bibliometrics, the scientific knowledge atlas is a graphical form of combing the development history and context of knowledge and combing the intricate relationship between knowledge in the process of bibliometrics study (4). The CiteSpace analysis software used in this study was developed by Prof. Chaomei Chen, a British Chinese. This is software for literature analysis based on Java to present relationship graphically. The software is simple, easy to operate, intuitive and visible (5). CiteSpace software obtains data by means of indexing the literature, and draw intuitive and visible graphic diagrams through the co-occurrence analysis, which can be used to explore the frontier and future development of a research topic. This study will draw on the data presentation of CiteSpace software to sort out the research of Chinese Digital Museum based on a procedural and thematic perspective.

RESULTS AND ANALYSIS

The Development Stage of Digital Museum Research

The number of articles published in a certain field can reflect the development history and trend, the evolution

Keywords	Year	Strength	Begin	End	2000-2019
Cultural Institution	2000	5.4129	2003	2007	
Museum	2000	5.0320	2003	2004	
Digital Museum	2000	5.1536	2005	2009	
Virtual Museum	2000	3.1793	2014	2016	

Figure 1. Highlights of Keywords in the Field of Digital Museums from 2000 to 2019.

CiteSpace, v. 5.6.R5 (64-bit)
 June 18, 2020 4:34:57 PM CST
 WoS: D:\data for citespace\digital museum\museum\data
 Timespan: 2000-2019 (Slice Length=1)
 Selection Criteria: g-index (k=25), LRF=3.0, LBY=B, e=2.0
 Network: N=511, E=1054 (Density=0.0081)
 Largest CC: 359 (70%)
 Nodes Labeled: 1.0%
 Pruning: Pathfinder

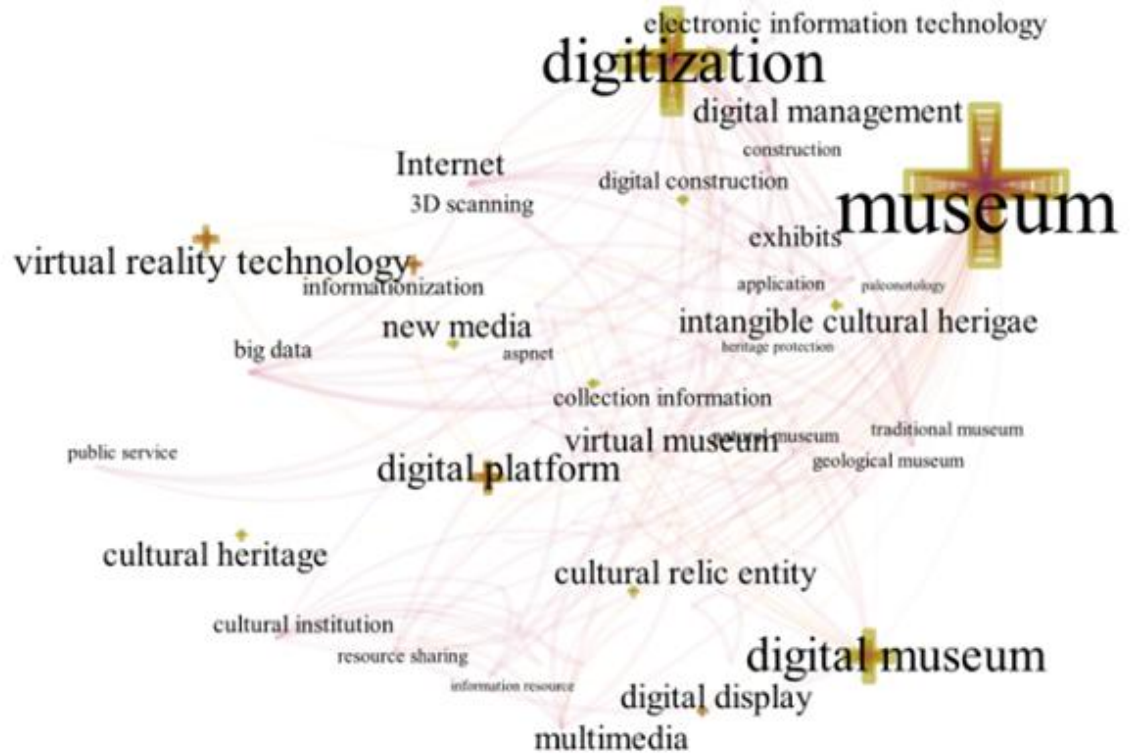


Figure 2. The Knowledge Graph of Keyword Co-occurrence in China Digital Museum.

process and the future dynamic development potential of this field. The digital museum research in China can be roughly divided into two stages according to the published literature: the first stage was the slow development stage (2000-2012), during which the total number

of papers published in 13 years were 173 that account for 37.12% of the total published articles. The second stage was the spiral upward development stage (2013-2019), during which a total of 293 articles published within six years.

The first stage showed that the development of digital museums is consistent with its background. On the one hand, emerging technology applications have brought the possibility of the development of digital museums. The development of computer, communication and microelectronic technology has promoted the realization of information storage and management, network transmission and resource sharing (6). On the other hand, the growing cultural needs also require the openness of historical relics. As the place for obtaining knowledge information has gradually shifted from libraries and museums to multiple channels such as the Internet, TV, and radio stations, which puts forward requirements for the unique status of the museum to display knowledge. Coupled with the accelerated pace of life, people not only reduce the time to visit the museum; at the same time, the new cultural entertainment also diverted a large number of museum audiences. The Digitalization Committee of the China Museum Society and the Intelligent Building Technology Training Office of the Cadre Academy of the Ministry of Construction of China also recognized the problems facing museum development. Therefore, the “Museum Intelligent, Digital, and Informational Construction Special Forum” was jointly held, and the journal of Intelligent Building and City Information was renamed as Intelligent Building and Smart City was used as a window to promote the forum, and it was also a commitment responsibility for publishing the forum results. Of the 23 articles published in 2004, 9 papers were all from this journal.

The second phase of research on “Digital Museum” is based on the transition from “why” to “how” in the context of continuous and diverse technological development. According to the results of CiteSpace’s research emergent terms, it is different from the discussion of the unilateral concepts and blueprints of “digital museum” and “digital construction”. The theme of the second phase focuses on “intangible cultural heritage”, “historical relics management”, “3D scanning”, “virtual reality”, “big data” and “information construction”. This shows that the research scope of digital museums has gradually expanded, and the research direction is mainly toward the technical level, and the refined development has gradually been achieved (Figure 2).

The Focus of Digital Museum Research

Table 1 lists the top 10 cited literatures on digital museum research in China, focusing on the mainstream thinking about the understanding and content construction of digital museum concepts.

In terms of definition, Li (7) and Yang (8) had similar views. From the innovation of digital museums in the form of information storage and organization, they proposed that digital museums collect, manage, display and process all aspects of removable and non-removable historical relics in digital form, and realize the information management for users to provide various services such as digital display, education and research. This “digital museum” understanding was based on the digital interpretation of physical museums. Chen and Zhu (9) no longer discussed whether the museum was “virtual” or “entity”, but tried to balance the museum as a “container” and “content”. They believed that the digital museum should not only be used as an information container to display historical relics, but also on the basis of an in-depth understanding and analysis of historical relics, through spatial hierarchy planning, streamline setting, plane and internal exhibits arrangement, light use as well as color matching, to provide the audience with a “stage” full of dramatic effects. Corresponding to this, as a “virtual museum”, it should not only serve as a platform for historical relics, but also as part of helping in-depth interpretation of the historical relics.

In the discussion of building a digital museum, based on its unique function, researchers have more analyzed the innovation of collection and display. Digital collection includes database construction (10), historical relics information entry (11), and supporting resource construction (12). The Northwest University Archaeological Digital Museum is an active practice in the collection of digital museums. This museum first screened historical relics based on value and academic status, and then used 2D or 3D information collection. The 3D information collection used the 3 space FastSCAN handheld 3D digital scanner from Polhemus in the United States and the 3D camera from Inspeck in Canada. On this basis, the information was entered into Microsoft SQL Server 2000 as the back-end database system, which supports the retrieval of content features such as colors, textures, and shapes, so that users can accurately understand historical relics information (13). The 3D scanning technology of the University Archaeological Digital Museum also uses Inspeck’s 3D camera for contact and non-contact technology information input, and constructs a virtual archaeological site hu-

Table 1. Top 10 Cited Documents of China Digital Museum Research.

#	Author (Year)	Title	Cited
1	Gang Chen (2007)	On the Concept, Characteristics and Development Model of Digital Museum	110
2	Xiangming Yang (2006)	Digital museum and related issues	83
3	Wenchang Li (2008)	China's digital museum in development	58
4	Hui Xiang et al. (2003)	Design and Implementation of the Archaeological Digital Museum of Shandong University	56
5	Jianqiang Yan (2004)	Dissemination and experience of computer network era museum display	51
6	Xiaodong Zhu et al. (2004)	The Design and Establishment of the Archaeological Digital Museum of Northwest University	49
7	Guodong Rong (2002)	Application of Inspeck3D-DF 3D Scanner in Digital Museum	47
8	Hongjing Chen & Shuang Chen (2000)	Talking about Digital Museum	47
9	Jianming Wang (2011)	Research on Intangible Cultural Heritage Protection Strategy Based on Digital Technology	46
10	Xuefang Zhu (2011)	Discussion on the Digital Construction and Service Integration of Information Resources of Tubo Archives	46

Table 2. Top 10 Authors of the Number of Articles Published by the China Digital Museum.

#	Author	Articles	Affiliation	Geography
1	Yuchang Wang	5	Gansu Provincial Museum	Northwest China
2	Xuefang Zhu	5	Nanjing University	East China
3	Hongjing Chen	4	Fudan University	East China
4	Jianping Zhang	3	Zhejiang University	East China
5	Yun Huang	3	Chinese National Museum	North China
6	Guode Li	3	Shenyang Normal University	Northeast East China
7	Ye Tian	3	Liaoning Normal University	Northeast East China
8	Huiling Song	3	China University of Geosciences (Wuhan)	Central China
9	Hui'e Liang	2	Jiangnan University	East China
10	Baojin Li	2	Guangzhou University of Traditional Chinese Medicine	South China

Table 3. Top 10 Research Institutions of China Digital Museum.

#	Institution	Articles	Province or City	Geography
1	National Museum of China	7	Beijing	North China
2	Gansu Provincial Museum	5	Gansu	Northwest China
3	Zhejiang Natural History Museum	5	Zhejiang	South China
4	China Geological Museum	4	Beijing	North China
5	Shandong Museum	4	Shandong	North China
6	Shanghai Museum	4	Shanghai	South China
7	Shaanxi University of Science and Technology	3	Shaanxi	Northwest China
8	Shenyang Normal University	3	Liaoning	Northeast China
9	Jiangxi Provincial Museum	3	Jiangxi	South China
10	Fudan University	3	Shanghai	South China

man-machine interface to enhance immersion and interactivity (11). Zhu analyzed the feasibility of combining digital information between museums, libraries, and archives, and found that the combination of library-museum-archive is a good way to improve the effect of information dissemination and integrate national investment, as well as the effective use of resources and development (12).

Different from physical museums, due to the openness and uncertainty of the network, copyright issues and network security are the key points in the construction of virtual museums. Therefore, each electronic museum has different countermeasures. The Northwest University Archaeological Digital Museum used visible and invisible watermarks for the processing of image copyrights, adding images individually or in batches without damaging the image quality (13). In addition, Xiang et al. also mentioned the protection of multimedia information encryption technology for copyright (11). The Shandong Digital Museum brought together mobile data from various regions and cities to the big data storage and processing center, and regularly backed up to ensure the security of digital resources and improve the capability of the platform's continuous service.

Distribution of Research Publications in Digital Museums

As shown in **Table 2**, among the top ten authors in the number publications of digital museums in China, Yuchang Wang and Xuefang Zhu published as many as five articles, ranking the first and the second; followed by Hongjing Chen and others. Of the top 10 authors, eight were from universities and only 2 were from museums. Furthermore, it was found that researchers from three universities, Nanjing University, Zhejiang University, and Shenyang Normal University, were all researching the digital museum from a technical perspective; researchers from Fudan University and Liaoning Normal University were conducting cultural and academic research from a professional perspective; and researchers at China University of Geosciences (Wuhan), Jiangnan University, and Guangzhou University of Traditional Chinese Medicine are conducting research on various theme topics. This showed that researchers have different directions for digital museums, which can be classified as professional, technical, and theme research. In terms of geographical distribution, the top 10 high-

yield authors had four in East China, two in Northeast China, one in Central China, one in North China, one in Northwest China, and one in South China. This showed that the geographical distribution of researchers in China's digital museums was obvious, and the southwest region was relatively lacking. This study found that the collaboration of high-yielding authors was not high, and most of the digital museum researchers were in a state of fighting alone and less related to each other.

Table 3 shows that the high-yield institutions for digital museum research in China were mainly museums. The top 10 were the National Museum of China, Gansu Provincial Museum, Zhejiang Natural Museum, China Geological Museum, Shandong Museum, Shanghai Museum, Shaanxi University of Science and Technology, Shenyang Normal University, Jiangxi Provincial Museum and Fudan University. This showed that the research power of China's digital museums is mainly concentrated in the professional museum system, and these museums are basically above the provincial level. In terms of geographical location, the top 10 high-volume research units occupy four in East China, three in North China, two in Northwest, and one in Northeast, but Southwest and South China are slightly lacking.

To sum up, the current research deficiencies in China's digital museums are: (i) Different researchers have a low awareness of cooperating with each other, and have not formed a state of joint research and mutual promotion. The status of cooperation between various research units is also lacking, and the establishment of relevant collaboration platforms among research institutions is not formed (14). At present, cooperative research and collaborative cooperation in the general environment have become a major trend. In China, changing the previously isolated situation, forming a cooperative consciousness between authors, and forming a collaborative mechanism between research institutions are the urgent tasks facing the China Digital Museums. (ii) The geographical distribution of China's digital museum research is uneven. There are relatively many publications on research in East and North China, and relatively few publications in Southwest and South China.

CONCLUSION AND SUGGESTION

This research is based on the data from the CNKI database related to digital museum themes from 2000 to 2019. Using CiteSpaceV software as a research tool, the

analysis found that the progress of digital museum research in China since the 21st century is divided into two major stages according to the number of published literature. The first stage is a slow development stage (2000-2012), and the second stage is a spiral rise development stage (2013-2019). The current research still has the following deficiencies: On the one hand, there is insufficient cooperation between the research subjects, and there is less cooperation between museums, universities and museums. Most of the research theories and technological innovations come from colleges and universities, and the practical experience of research comes from museums. This cannot effectively promote the excellent practice of digital museums in comparison and improvement, nor can universities promote the theoretical development of digital museums in practice. On the other hand, the research of digital museums generally emphasizes the summarization of practical experience and is lighter than the systematic theoretical standards. Feng summarized the theories involved in digital museums including modern education concepts, mass communication, cognitive psychology, and exhibition art theories (15). These theories can only provide theoretical suggestions for the construction of digital museums, but they cannot give a museum construction framework and evaluation system. The construction of the digital museum is the demand of the museum's own development under the trend of the times, and it is also the requirement of the growing cultural needs of the people.

Therefore, the protection, collection, education, and creative function of historical relics after the construction of digital museums need to be judged by scientific standards.

Therefore, it is necessary to strengthen the cooperation, exchange and collaboration between museums and museums, and between museums and universities. The first is to abandon the monolithic and single-play research status, and form a centralized inter-regional cooperation. At the same time, strengthen the research of the southwest region and form a cooperative research situation in different regions. Share experience of digital museum construction under similar circumstances, different cultural backgrounds, and major audiences among regions. In the experience sharing of practical activities, the development characteristics and framework unique to digital museums and different from traditional museums are formed. The deep-level cultural resource information can be excavated, deconstructed, restructured, interpreted and displayed. The second is to play the role of university cooperation. On the one hand, colleges and universities and museums coordinate activities to increase the number of education objects and expand the influence of the museum; on the other hand, give full play to the leading role of universities in theory and technology, and actively help museums solve digitalization. So as jointly formulate corresponding framework indicators to achieve an efficient development. ■

ARTICLE INFORMATION

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