Construction and Analysis of Domestic BIM Knowledge Map Based on CiteSpace

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Abstract—In this paper, CNKI is used as the data source, and CiteSpace is used to analyze the literatures related to BIM research types in the core journals of CNKI in the recent ten years. The research shows that green construction and prefabricated building are the frontiers of BIM research in China, while visualization, project management and construction are the current research hotspots.

Keywords-BIM; CiteSpace; research hotspot; knowledge graph; Research trends

1 INTRODUCTION

BIM, as an emerging technology and concept, has become the focus of attention of domestic and foreign researchers and people in the construction industry [1]. At the same time as the deepening of the domestic scholars for BIM technology research, its research is becoming more and more mature, but in the systemic research of BIM this piece of content is relatively scarce, so in order to further help scholars explore BIM future development trends and the hot spots, based on the literature metrology, this paper use CiteSpace information visualization technology, The research contents of building information model from 2010 to 2020 are systematically sorted out and analyzed in order to help researchers clarify the dynamics and direction of disciplinary development and promote the development of building information model research in China.

2 RESEARCH METHODS AND DATA SOURCES

2.1 Introduction to Research Tools

Citespace, developed by Professor Chaomei Chen of Drexel University, is one of the most distinctive and influential information visualization analysis software developed in the context of scientometrics, data and information visualization [2]. The Chinese name "citation space" is a citation visualization analysis software gradually developed under the background of scientometrics and data visualization. Because the structure, law and distribution of scientific knowledge are presented through visualization, the visualization graph obtained through this method is called "scientific knowledge graph". It can not only provide the function of literature mining, but also provide the function of co-occurrence analysis among other knowledge units, such as the cooperation among authors, institutions, countries and regions [2].

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In this paper, CiteSpace software was used to conduct citation analysis, and the scientific knowledge map was drawn by visualization technology. The evolution process of a knowledge field was concentrated on a citation network map, and the research frontier represented by the citation node literature and co-citation clustering of knowledge base was automatically identified. It makes the analysis of BIM literature based on CiteSpace more vivid and accurate.

2.2 Data source and processing

CNKI database is the largest Chinese database in China at present. Therefore, CNKI is used as the retrieval source in this study, and the keywords are "BIM" OR "building information model". The types of articles are SCI, EI, core journal, CSSCI and CSCD, and the time period is from 2010 to 2020. In order to ensure the reliability of the research data samples, manual screening of the literature was carried out. Firstly, the literature that was obviously not related to the research content was removed, such as the research of disciplines other than architecture and patents, and finally 1517 literatures were obtained. Taking this as a sample, the dynamic analysis of building information model is carried out with Citespace software.

3 ANALYSIS OF RESEARCH RESULTS

3.1 Dispatch analysis

According to the number of publications related to BIM in China from 2010 to 2020 (Figure 1), it can be seen that the number of publications in this field has been on the rise and reached its peak in 2017. The main reason is that the Ministry of Housing and Urban-Rural Development issued the 2011-2015 Construction Industry Informatization Development Outline, which promoted the rapid growth of construction informatization research and reached its peak [3]. The number of articles published in 2018 decreased, indicating that the research in that year was saturated. In the following two years, the number of articles published reached a new high, indicating that BIM related research is still hot.

Therefore, from the overall trend of BIM publications, BIM related research is in constant development, and it is expected that the number of publications in BIM research will continue to grow in the future.

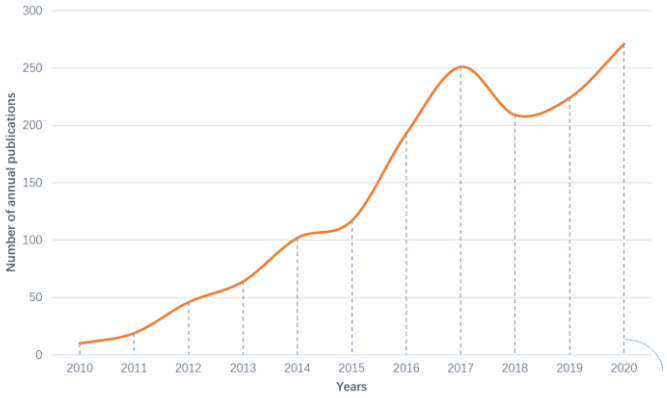

Figure 1. The number of domestic BIM publications in the past decade

3.2 Analysis of issuing agency

The cooperation network map of issuing institutions as shown in Figure 2 was established through CiteSpace. The time segment was 2010-2020, the slice life was 1 year, and the node type was selected as institution. The cooperation knowledge map of building informatization institutions was obtained as shown in Figure 2, with 362 nodes, 179 connections and 0.0027 network density. It can be seen from this that the distribution among institutions is scattered, with a large number of nodes, but a small number of connections and network density, indicating that although there are many informatization issuing institutions, the connections among them are insufficient, and the structure of institutional cooperation network is loose and the density is not high.

It can be seen from Table 1 that tongji University (21 papers), Huazhong University of Science and Technology (20 papers) and Tsinghua University (18 papers) are the top three universities with relatively strong strength. Also followed by hohai university college of water resources and hydropower (14), xian building university of science and technology institute of civil engineering (14), and Shanghai jiaotong university, department of civil engineering (12), in addition to the colleges and universities in the top 10 and despatched to pay the second engineering survey and design institute co., LTD., build three innings group co., LTD. And Beijing construction group co., LTD. These companies also have a lot of research achievements in BIM.

Although there are a lot of papers published by various research institutions, there is a lack of cooperation and further in-depth communication between them, which is not only a lack of cooperation between universities and universities, but also a lack of cooperation and communication between universities and companies, as well as between companies.

Table 1 Cooperation networks for institutions

Institutions	Counts
Tongji University	21

Huazhong University of Science and Technology	20
Tsinghua University	18
Hohai university college of water resources and hydropower	14
Xian building university of science and technology institute of civil engineering	14
Shanghai jiaotong university, department of civil engineering	12
China Communications Second Aviation Engineering Survey and Design Institute Co., LTD	10
China Construction Third Bureau Group Co. LTD	9
Beijing Construction Engineering Group Co. LTD	8

3.3Author analysis

The Author node is selected in the software CiteSpace, and the number of key domestic researchers in the field of BIM development and their published literature can be obtained after running. According to the analysis results of the first author in the literature statistics, select post number in the top ten of the author, as shown in table 1, core authors mainly include Joyce, in the field of BIM Wang Ru, Yang Zhenqing, Shi Jianyong, xiaoling zhang, its dispatch number are above eight, another number in at least six jianping, the author of the province, xiao-ping zhou, Zeng Shaowu Wang Tingkui, liu.

The author knowledge map shows that there are 457 nodes and 454 connections, and the density is 0.0044. The number of nodes and connections is large, and the density is moderate. It can be seen that the cooperation among scholars is close, as shown in Table 2. Joyce, who ranks top in quantity, cooperated more with Zhou Xiaoping, Yang Zhenqing cooperated closely with Zhang Xiaoling, Song Pingping, Zhao Wei, etc., and other scholars also had certain cooperative relations.

Table 2 Statistics of core authors in BIM field

Year	Author	Count
2015	WangJia	10
2014	WangRu	9
2015	YangZhenqing	9
2017	AhiJianyong	8
2015	ZhangXiaoling	8
2010	Zhangjianping	7
2013	Wangtingkui	7
2013	Liuzhansheng	7
2017	Zhouxiaoping	7
2017	Zengshaowu	6

3.4High-frequency keyword analysis

Keyword nodes are highly condensed on the research topic of the paper, and high-frequency keywords reflect the hot spots of relevant research in a specific time period [4]. Select the Keyword node in CiteSpace, and manually merge the keywords with the same meaning. TimeZone View is used to obtain the Keyword atlas after running the software, and extract the top ten keywords with frequency.

It can be seen from Table 3 that the hot spots of BIM research in China are informatization, BIM technology, building information modeling (BIM), visualization, project management, Revit and construction. BIM technology has the highest frequency of occurrence (238 times), with centrality in the second place, and the keyword with centrality in the first place is informatization, with a frequency of 117 times. The following keywords are building information model, in which there is little difference between centrality and BIM technology, but the frequency of occurrence is only 50 times. The fourth keyword is visualization, with a centrality of 0.15 and a frequency of 41, which appeared at the same time with BIM in 2010. The keywords ranked lower were project management, Revit and construction, indicating that BIM began to gradually integrate with practice in 2012 and was applied in project management and site construction.

Table 3 BIM research hotspot high-frequency words

Count	Centricity	Year	Keywords
117	0.23	2012	informatization
238	0.2	2010	Bim technology
50	0.19	2010	Building Information Modeling (BIM)
41	0.15	2010	visualization
32	0.12	2012	The project management
36	0.11	2013	revit
29	0.1	2013	construction

3.5 Research trend analysis

Generally speaking, research trend is to provide scholars with the latest trend of their research, further judge the trend of research and possible problems to be solved, so as to promote the development and innovation of the research field. After screening based on the data provided by CNKI, Citespace software was used to analyze the emergence words in related fields of cost sharing, and the top 15 emergence words were obtained as shown in Table 4. Then combined with relevant literature on its development trend and frontier analysis.

In this paper, the research trend of BIM field is observed by using the Keyword emergence table in CiteSpace, and the high-frequency Keyword emergence table of BIM field is drawn with "Keyword" as the node. The research process can be divided into the initial stage, the embryonic stage, the development stage and the mature stage.

As shown in Table 4, 2010-2012 is the initial stage of BIM, during which BIM gradually comes into people's view.

The breakout time of "building information model" is from 2012 to 2015, which is the embryonic stage of BIM. Relevant BIM studies are developing gradually, indicating that BIM has attracted more attention from scholars during this period, especially from 2013 to 2015.

From 2016 to 2017, with the increase of government support and market demand, the development of BIM has been extended to the stage of in-depth application, which is also the stage of further development of BIM. Project management, collision detection, steel structure, simulation, construction technology, green construction, etc., indicate that this period aims to apply BIM technology to the actual construction process, and implement the huge BIM standard research system to the construction level convenient for operation [5]. In August 2016, the Ministry of Housing and Urban-Rural Development issued the outline for the Development of Construction Industry Informatization from 2016 to 2020, proposing to comprehensively improve the level of construction industry informatization during the 13th Five-Year Period, thus promoting the combination of BIM and other technologies in the construction industry.

The period from 2018 to 2020 is the mature stage of BIM. After the first three stages, BIM has gradually moved from theory to practice. In this stage, prefabricated building has gradually entered the scope of scholars' attention, and the combination of prefabricated building and BIM is a hot research topic.

Table 4 Top 15 Keywords with the Strongest Citation Bursts

Keywords	**Strength**	**2010 - 2020**
Construction companies	6.5852	
Lean construction	3.6956	
BIM	4.4704	
Building information model	15.435	
project management	2.9542	
Collision detection	2.6206	
steel structure	3.1433	
simulation	2.6206	
construction technique	3.0996	
in-depth blueprint	7.0227	
informatization	19.4967	
Collision check	2.6456	
Green construction	2.7075	
research	3.8726	
Prefabricated building	3.3957	

4 CONCLUSIONS

In this paper, visual knowledge mapping is carried out based on Citespace, and relevant literatures in the domestic BIM field during 2010-2020 in CNKI database are taken as data samples. The number of publications of research institutions and collaborative knowledge atlas, the cooperative relationship and the number of publications of core authors, the analysis of research hotspots and the evolution trend are analyzed respectively. The following conclusions are drawn: from the number of articles published from 2010 to 2020, BIM related research results show an increasing trend; Secondly, the distribution of research institutions in China is loose and the close cooperation relationship has not been formed for the time being. The cooperation among authors is relatively close. The research on BIM is gradually moving from theory to practice. From the perspective of high-frequency keyword table and keyword emergence table, the current research hotspots in BIM mainly include visualization, project management, construction, etc. The research frontier mainly includes green construction, prefabricated building and so on.

In view of the above conclusions, the author puts forward the following suggestions for future BIN related studies:

(1) Strengthen cooperation and in-depth exchanges

The cooperation between the core institutions and the authors should be strengthened, especially the deeper communication and research between the research institutions, so as to drive the rapid development of the whole BIM field. Although each research institution aims at different research contents, it is precisely because of this difference that another perspective can be stimulated to explore new fields and applications of BIM research.

(2) Interdisciplinary and mutual integration

Academia and construction industry should grasp the latest trends of relevant researches on BIM in time, try to integrate BIM with other technologies, and constantly improve the theoretical system of BIM in China.

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