Digital Transformation: Visual Analysis Based on CNKI and Citespace

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Abstract: In order to cope with the new situation and new challenges, all fields of economy and society need to grasp the new opportunities of digital development and accelerate digital transformation. Focusing on the theme of "digital transformation", this paper uses CiteSpace 6.2.4 software to visualize and analyze the knowledge graph of 1,898 documents in CNKI database from 2010 to 2023. The study found that: the number of digital transformation literature has shown a significant growth trend in recent years. The partnership between scholars and institutions has to be strengthened. The research hotspots mainly cover four major themes, namely, industrial digitalization, digital governance, digital publishing, and higher education, and the hotspot evolution has shifted from the initial digital publishing and digital transformation to the research on the digital economy and enterprise digitalization. Based on the findings of the study, an outlook for future digital transformation research is proposed.

***Keywords*:** digital transformation, digitalization, digital economy, CiteSpace

1. Introduction

With the rapid development of information technology, digital transformation has become an important trend in the development of contemporary society. In order to better realize digital transformation, relevant departments of China have issued a series of policies to provide policy support for digital transformation. Plan for the Overall Layout of China Digital Development and the 14th Five-Year Digital Economy Development Plan both emphasize the significance of digitalization for China's future development, and at the same time, they point out the direction of digital transformation has also been indicated. Digital transformation not only has a profound impact on business organizations, government agencies and social life, but also brings new challenges and opportunities. It is of great significance to grasp the current status and hotspots of digital transformation research, and to study the future development trend of the digital transformation field, so as to assist scholars in their research by understanding the overall situation of digital transformation research. Therefore, this paper collected 1,898 literatures on digital transformation from Peking University Core and CSSCI journal papers in the CKNI database from 2010-2023 (until October 20, 2023) as a source of data, and conducts bibliometric analysis of China's digital transformation-related literatures by using CiteSpace software in order to have a more in-depth understanding of the development and evolution of digital transformation in China.

2. Data Sources and Research Method

2.1 Data Sources

Considering the research on digital transformation before 2010 was fragmented, in order to ensure the reliability and accuracy of the analysis results, this paper collected and searched the literature data after 2010. This paper takes the Peking University core and CSSCI journals in the China National Knowledge Infrastructure (CNKI) database as the data source, set the time range as 2010-2023, the search topic as "digital transformation", the search condition as "precise", the source category was "Peking University Core" and "CSSCI". 1898 Chinese documents were retrieved on October 20, 2023, after excluding non-research articles, such as news reports, academic conferences, and commentaries.

2.2 Research Method

Bibliometrics is a method of analyzing the amount of literature and the number of authors by integrating the knowledge of mathematics, statistics and bibliography. This paper adopts the scientific knowledge graph in bibliometrics, use CiteSpace 6.2.4 software to visualize and statistically analyze the literature of core journals on CNKI platform during the period of 2010-2023, and set the node types of Author, Institution, and Keywords respectively to run the analysis, and then analyze the authors of the articles, Author, Institution and Keywords were set to run respectively, and the authors, institutions and keywords were analyzed to show the research status of China's digital transformation in more than ten years.

3. Analysis of China Digital Transformation Research

3.1 Analysis of the Number of Published Articles

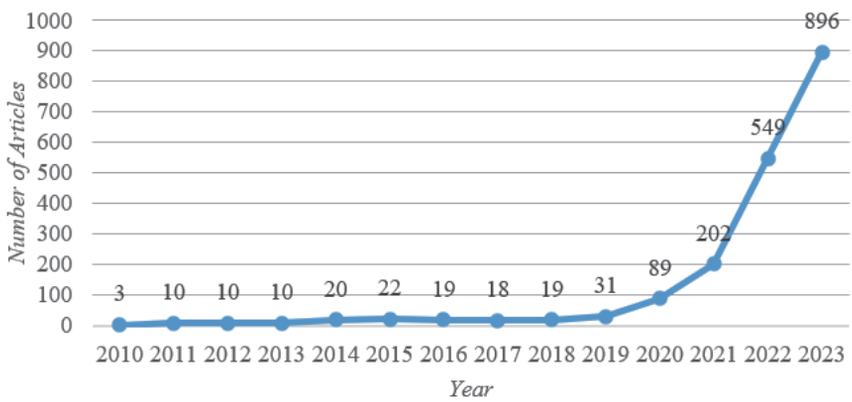

Figure 1. 2010-2023 CNKI digital transformation annual article volume statistics.

Changes in the number of published articles can present the development status and research trend of a certain field to some extent. The annual publication volume statistics of the retrieved 1898 documents are shown in Figure 1. From Figure 1, it can be seen that during 2010-2023, China's publication volume for digital transformation has shown an overall upward trend, and the publication volume of Chinese core journals before 2014 was very small, roughly 10 and below; the annual publication volume from 2014-2018 was around 20, showing a relatively stable growth trend; from 2019 to October 20, 2023, the number of articles has shown a rapid growth trend, indicating that in recent years, the research on digital transformation in Chinese academia has been increasingly hot, and the field of digital transformation is triggering a high degree of attention from relevant scholars in China.

3.2 Author Collaboration Mapping Analysis

Author collaboration mapping can reflect the core authors as well as the collaborative relationship network among different authors. According to Price's law, Nmax is the number of publications of the most prolific authors, and N is the minimum value of the number of publications of the core authors, as equation(1). Therefore, in this study, authors with 3 or more publications are considered as key authors. According to CiteSpace statistics, it was found that there were 53 core authors during the time period of the study, including Wu Fei and Zhu Zhiting and so on.

$$N = 0.749\sqrt{N_{\max}} \tag{1}$$

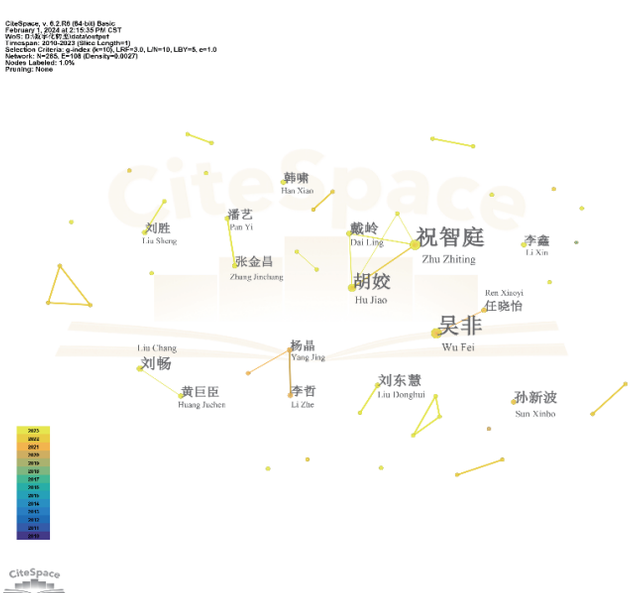

Figure 2. Author collaboration mapping.

In CiteSpace, set the node type as 'Author', the time interval as 2010-2023, and set slice as 1 to get the author cooperation graph as in Figure 2. The larger the author node in the graph, the larger the author's publication volume in the related researcher, and the thicker and deeper the connecting line between the nodes indicate that the cooperation between different authors is closer and closer.

In the Figure 2, N (number of nodes) is 285, connecting lines E are 108, and the density is 0.0027. It can be seen that Wu Fei, Zhu Zhiting, Hu Jiao, Liu Chang, and Liu Donghui have larger names; these scholars have published more papers. In the authors' cooperation network, Zhu Zhiting, Hu Jiao and Dai Ling form a small cooperation network and their research focuses on the digital transformation in the field of education. However, because the research on digital transformation in various fields is still in its infancy, overall, the academic partnership between authors is still weak, and the deep-level communication and cooperation among scholars needs to be strengthened.

3.3 Institution Analysis

The analysis of issuing institutions can help to clarify the current inter-institutional cooperation relationship and provide suggestions for further strengthening the cooperation. Adjust the node to Institution in CiteSpace and run the software to get the cooperation map of issuing institutions (Figure 3). The larger the node means the larger the number of articles issued by the institution, and the thicker and deeper the line between institutions means the closer the cooperation relationship between different institutions. From the figure, it can be seen that the Institute of Quantitative & Technological Economics, CASS, School of Economics and Management, Tsinghua University, Technology Engineering Technology Development Center, Guangdong Institute of Finance, and School of Open Learning and Education, East China Normal University are more rich in research on digital transformation and have strong academic and scientific research capabilities, and based on the corresponding relationship between the node color and the year as shown in the legend, the above institutions are also the more active research institutions in recent years. At the same time, four larger research networks have been formed centered on the Institute of Quantitative & Technological Economics, CASS, School of Economics and Management, Tsinghua University, Technology Engineering Technology Development Center, Guangdong Institute of Finance, and School of Open Learning and Education, East China Normal University, among which, the Institute of Quantitative & Technological Economics, CASS, School of Economics and Management, Tsinghua University are more closely cooperating with each other in terms of their research and have high scientific research levels, but the cooperation of existing research network is still relatively decentralized from a general point of view, and the awareness of cross-regional and cross-institutional cooperation still needs to be strengthened.

Figure 3. Mapping of institutions.

3.4 Keywords Analysis

3.4.1 Citation/Frequency Burst Analysis

Citation/Frequency Burst can reflect the changes of research hotspots and topics over a period of time, which helps to

grasp the hotspots of research frontiers. Clicking on "Citation/Frequency Burst" in CiteSpace software generates a keyword burst map of digital transformation research (Table 1), which refers to the words that have attracted widespread attention in the academic community within a certain period of time, and the study of this category of words can provide a direction for the next research. The study of this category of words can provide direction for the next research. The first seven emergent terms are shown in the figure, with the earliest being "digital publishing", and the most recent being "digital economy", "small and medium enterprises (SMEs)" and "artificial intelligence (AI)". The top three in terms of strength are "Digital Publishing" (11.77), "Transformation" (6.57) and "Education Transformation" (5.06). The keyword "digital publishing" has been in the foreground for 8 years, with a higher strength of influence. The keywords "digital economy", "SMEs" and "AI" have emerged in the past three years, and with the promulgation of relevant policies and the continuous improvement of digital transformation infrastructure, these keywords are still likely to be the research hotspots in the next few years. As can be seen from the table, the keyword "digital publishing" began to appear in 2011 and lasted for a long time; the keyword "transformation" appeared in 2012 and lasted until 2016; the keyword "education publishing" appeared in 2013 and in 2014 "digitization" gradually appeared along with China's economic and social development, and lasted for a longer period of time. 2014 to 2019, no other keywords appeared, which also corresponds to the relatively stable level of the number of articles in Table 1. The emergence of "digital economy", "SMEs" and "AI" from 2020 onwards reflects that the development of Chinese SMEs and the construction of digital infrastructure have entered a new stage of development. The emergence of these terms is closely related to the economic, policy, technological, and social environments of the time, but the study of digital transformation still has a lot of room for development nowadays.

Table 1. Top 7 Keywords with the Strongest Citation Bursts.

Keywords	Year	Strength	Begin	End	2010 - 2023
digital publishing	2011	11.77	2011	2018	
transformation	2012	6.57	2012	2016	
educational publishing	2013	5.06	2013	2019	
digitalization	2012	3.68	2014	2019	
digital economy	2020	3.03	2020	2021	
small and medium enterprise	2020	2.91	2020	2021	
artificial intelligence	2020	2.84	2020	2021	

3.4.2 Keywords Cluster Analysis

Figure 4. Keywords cluster.

Keywords are the summary and distillation of the content of the article, which can reflect the overall research content of the article through highly generalized words, and high-frequency keywords can reveal the research hotspots in a certain

field. In this paper, keywords of 1898 documents were analyzed and the keywords were clustered using the log-likelihood method (LLR), and a cluster diagram was obtained (Figure 4).

The Q value of the cluster is 0.5686, which is greater than 0.3, indicating a significant structure, and the S value is 0.8432, which is greater than 0.7, indicating that the clustering is efficient and persuasive. There are seven clusters in the graph, and the smaller the number of cluster labels, the greater the number of documents under that cluster.

Table 2 is obtained by sorting according to the LLR method, where size indicates the number of keywords contained under each label, and sihouette is used to measure the average homogeneity of the whole network, and the closer the score is to 1, the higher the homogeneity and the higher the reasonableness[1]. In terms of the number of nodes, the "digitalization" cluster contains the most keywords with 41, followed by "digital economy" with 34 nodes, indicating that the research literature on "digitalization" and "digital economy" is the most abundant. In terms of sihouette, sihouette has the highest number of nodes for "digital publishing", followed by "higher education", which indicates that the research related to the two is more closely linked. In the generated cluster diagram, #0 digitalization is highly correlated with the search term digital transformation, which has a broader scope and will not be analyzed in detail here. The remaining six clusters are divided into the following four categories: industrial digitalization (digital economy, manufacturing, enterprise innovation), digital governance, digital publishing, and higher education.

Table 2. Keyword cluster information (LLR)

Cluster ID	Size	Sihouette	Mean year	Name of cluster（LLR）
#0	41	0.738	2016	digitalization
#1	34	0.855	2020	digital economy
#2	32	0.772	2021	manufacture industry
#3	30	0.845	2022	enterprise innovation
#4	26	0.83	2021	digital governance
#5	25	0.965	2012	digital publishing
#6	17	0.916	2019	higher education

3.4.2.1 Industrial Digitalization

The keywords included in industrial digitalization are digital economy, manufacturing industry, and enterprise innovation, and the main research content of this cluster is the impact of digital economy on enterprise innovation especially in manufacturing industry, under which a large number of scholars have carried out a lot of research.

In the context of digital economy, enterprises are able to adopt digital technology to improve productivity, optimize products and services, and help enterprise innovation, which supports the digitalization of manufacturing enterprises. Chang Shangxin (2022) found that the digital economy plays an important role in the digital transformation of commerce and distribution enterprises through the study of China's A-share listed companies in commerce and distribution enterprises, and this transformation further promotes the innovation of commerce and distribution enterprises, which has a significant positive impact[2]. By constructing a regression model and taking manufacturing enterprises in China's A-share listed companies as a research sample, Tian Shuo et al. (2023) empirically analyzed it and found that the digital economy has a significant role in promoting enterprise innovation[3]. Northeast China has an irreplaceable position in China's manufacturing industry, seize the new opportunities for digital transformation can help revitalize the northeast, Wang Yuanyu et al. (2024) hold that the digital economy is the core driving force for the comprehensive revitalization of the northeast, which is based on the "4D" framework, analyzing that by increasing the density of population and economic activities, breaking down the distance barriers, reducing the degree of market segmentation and reshaping the competitive advantage, it can comprehensively empower the high-quality development of the northeast economy[4].

3.4.2.2 Digital Governance

The keywords extracted from Cluster3 "digital governance" are digital governance, digital government, technology empowerment, rural revitalization, local government, and the main research content of this cluster is to use digital methods to enhance the efficiency of government management, improve public services, and realize the digitalization of government governance. Thus, enhancing government efficiency and social governance. Scholars have studied digital governance from various aspects.

Jiang Wenlu et al. (2023) take the example of Beijing's digital governance reform of "Jie Su Ji Ban" to illustrate the positive role of digital governance in promoting the transformation of government governance and advocate the promotion

of digital governance[5]. Zeng Fanjun et al. (2024) analyzed the provincial government data within 6 years by using dynamic QCA method based on the ecological theory of digital governance and grouping theory, found that the development of digital government depends on a good digital governance ecology, and provided references for the development of differentiated digital government in different regions[6]. Duan Yongbiao et al. (2023) argued that digital governance can empower urban governance and promote high-quality urban development, and solving the current bottlenecks of incomplete digital hardware and software, technology abuse and data risk, and insufficient talents can better promote the process of high-quality development[7]. Wen Jun et al. (2023) also believe that there are uncertainties in the current digital governance, such as the object technology, the subject's ability, and contextual change, which have become the risks faced by digital governance[8].

Overall, the topic of digital governance has only received attention from Chinese scholars since 2020, and most of the current qualitative research is based on the current state of development, with a lack of empirical research articles. With the development of the economy and society, the topic of digital governance will receive more attention from scholars.

3.4.2.3 Digital Publishing

The keywords extracted from Cluster 4 "digital publishing" are digital publishing, publishing industry, mass publishing, book publishing, targeting, which mainly discuss the impact of digital technology on the traditional publishing industry. The digital transformation of the publishing industry started earlier, and the research in this field is relatively rich, including a large number of empirical and qualitative studies.

With the arrival of the Internet era, the concept of digital publishing has been gradually put forward, and at the early stage of the digital transformation of the publishing industry, She Jingxiong (2011) puts forward suggestions on the development of China's digital publishing and traditional publishing industry based on China's national conditions[9]. 2012-2013 China's Digital Publishing Industry Annual Report Group, etc. (2013) analyzed the domestic and international environments of the development of the digital publishing industry, domestic digital publishing development scale, industry situation in order to provide support for the subsequent development of digital publishing[10]. Zhang Xinxin (2014) puts forward thoughts and prospects on the industrialization promotion of digital publishing from the perspective of professional publishing[11].

Digital publishing has experienced more than ten years of development so far, and in recent years, digital publishing is still concerned by some scholars, Wu Ling et al. (2017) believe that the digital publishing strategic alliance is the trend of the future evolution of the publishing industry, and constructs the digital publishing strategic alliance through the analysis of the evolutionary game model[12]. Yu Mingming (2020) believes that the changes in the status of readers in recent years significantly affect the development of digital publishing enterprises, and provides countermeasure suggestions for digital publishing enterprises based on the changes in the status of readers[13]. Wang Fanyun et al. (2022) analyze the problems of current yearbook publishing, put forward the idea of digital transformation, and take the construction of the yearbook digital publishing platform of Central South University Press as an example, which provides a useful reference for the integrated development and knowledge service of yearbook publishing[14].

3.4.2.4 Higher Education

The keywords extracted under cluster 5 "higher education" include higher education, digital literacy, vocational education, educational change, and the research in this field is mainly qualitative, and promoting the high-quality development of higher education through digital transformation is the focus of scholars' research on the CNKI platform.

Chen Lin (2023) analyzes the importance of digital transformation to empower the high-quality development of higher education from the value mechanism and reality basis, and proposes promotion strategies[15]. Li Xiaohong et al. (2024) constructed a digital transformation analysis framework based on the TOE framework and analyzed 28 cases of digital transformation practice in higher education in China through the csQCA method, and found that a single condition could not achieve a high level of construction, and that digital technology embedding and strategic planning could promote the digital transformation of higher education under specific conditions[16]. Bao Shumei et al. (2024) argued that the integration of digital technology and higher education has promoted the digital shift of higher education research, and also pointed out that the digital transformation of higher education is accompanied by potential risks such as the "digital leviathan", the lack of value rationality, and digital ethics and security issues[17].

4. Summary and Outlook

4.1 Summary

With the help of CiteSpace software, this paper conducted a knowledge graph visualization and analysis of the digital transformation literature of 1898 core journals published in the CNKI database during the period of 2010-2023, and reached the following conclusions:

The number of literatures related to digital transformation has shown an overall upward trend during the period of 2010-2023 especially since 2019, and it is expected that the literature in the field of digital transformation will still be on the rise in the future. In terms of the authors of the literature, the number of core authors is low and the authors' partnership is small. From the perspective of the issuing institutions, the issuing institutions are mainly universities and research institutes, and there is a certain cooperation relationship between institutions, but there is a lack of cross-regional cooperation. Through keyword clustering, it is found that the topics of digitalization, digital economy, manufacturing, enterprise innovation, digital governance, digital publishing, and higher education are the hot topics of digital transformation in the past, and the digital transformation occurs in many fields, such as economy, enterprise, government governance, and education.

4.2 Outlook

With the continuous progress of technology, digital technology will become more popular and mature, and digital transformation will also more profoundly change the future development of various industries. Currently, scholars have carried out extensive research on digital transformation, and in the future research can be carried out from the following aspects:

First, expand the scope of research. Most of the current digital transformation research is focused on manufacturing, publishing enterprises and education, public administration and other fields, for the State Council delineated the digital transformation of key industries, such as agriculture, services, energy and other aspects, should expand the relevant research, for industry, manufacturing and other areas that have been researched should accelerate the theory into practice.

Second, focus on organizational change and management innovation. Digital transformation poses new challenges to organizational structure, management mode and talent demand, and future research can focus on how to achieve effective organizational change and management innovation to adapt to the competition and development needs in the digital environment.

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