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Research on the Distribution and Trend Analysis of Digital Transformation of Chinese Enterprises Based on CiteSpace

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Abstract. Enterprise digital transformation has always been a hot issue in Chinese industries. To grasp the hot topics and development trends of enterprise digital transformation research, this paper uses the visual analysis software CiteSpace to analyze the distribution and trend of research on enterprise digital transformation in CNKI journal papers and draws the following conclusions. The research on the digital transformation of Chinese enterprises first started in 2011, and the period of 2011-2019 belongs to the initial stage and has entered the rapid growth stage since 2020. Most of the authors and research institutions in this field in China are independent researchers and have not yet formed a complex cooperative network. Research on the digital transformation of Chinese enterprises initially started in the publishing industry and gradually extended to various sectors. Future research on the digital transformation of Chinese enterprises will develop in the "digital transformation of state-owned enterprises" and "digital transformation of agricultural enterprises."

Keywords. Enterprise Digital Transformation, CiteSpace, Visual Analytics, Research Distribution, Cutting Edge Trends

1. Introduction

In 1971, the world ushered in the PC era, and in 1995, the "digital economy" was introduced, and its development prospects were envisioned. In the 21st century, communication technology has improved dramatically, the large-scale use of smartphones and mobile terminals has driven the Internet era, and the digital economy has become a significant force driving the steady growth of China's economy [1] The core methodology of transformation, the digital transformation of the service industry, continues to be active, and the digital transformation of agriculture is beginning to bear fruit (China Academy of ICT, 2022).

Cloud computing, big data, blockchain, Internet of Things, artificial intelligence, and other technology development and large-scale application, the rapid growth of the digital economy, and the new crown epidemic to further promote the arrival of the digital

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economy era, digital transformation has become an essential part of China's national strategy. The "14th Five-Year Plan" for developing the digital economy points out that we should vigorously promote the digital transformation of industries, accelerate the digital transformation and upgrading of enterprises, and comprehensively deepen the digital transformation of critical sectors.

Figures for 2020 show China's digital economy reached 39.2 trillion yuan, the second largest in the world. With a year-on-year growth of 9.7%, it is firmly in first place in the world. Enterprises are the main body of China's developing digital economy. Still, there needs to be more analyses of the content of research and research trends on the digital transformation of Chinese enterprises. Few authors have applied the method of literature visualization analysis to sort out the research lineage and development trend of the digital transformation of Chinese enterprises. It cannot well reveal the development process of digital transformation of Chinese enterprises. Given this, this paper provides an in-depth analysis of the research distribution and trends in Chinese enterprises' digital transformation research through the visualization software CiteSpace. In this way, we can understand the current situation and problems of the digital transformation of Chinese enterprises. We can sort out the process of digital transformation of Chinese enterprises. This paper has specific theoretical value and practical significance in providing decision-making references for governments, enterprises, and scholars.

2. Literature Review

The advent of the digital economy has led to a fundamental change in the paradigm of enterprise management, and the digital management trend has struck. More and more scholars have recognized the importance of digital control in enterprises and studied the digital management model in many fields. Enterprise digital transformation refers to the process by which enterprises bring about significant changes in organizational attributes and achieve overall improvement through combining technologies such as information, computing, communication, and connectivity [2].

Most existing studies have focused on the impact of digital transformation on enterprises in economic efficiency and business behavior. Several scholars point out that digital transformation can enhance organizational flexibility, reduce business operation costs, increase operating income, and improve economic efficiency[3]. It can reduce financing costs and improve management efficiency[4], stabilize industrial chains, smooth supply chains, and enhance market competitiveness [5]. It can promote enterprise innovation and development[6] and alleviate the degree of financing constraints of enterprises [7]. It can reduce the cost of corporate debt [8].

At this stage, there are relatively few studies involving the process of enterprise digital transformation and its development trend. Some scholars point out that the digital economy is rapidly developing. Digital transformation is a critical path for the sustainable growth of enterprises [9]. China is entering a new set of rapid development of digital transformation of enterprises in traditional industries [10]. However, on the whole, the digital transformation of Chinese enterprises is still in its initial stage [11].

An analysis of previous literature shows that fewer research trends on the digital transformation of Chinese enterprises have been sorted out using bibliometric and visual analysis methods. This paper analyzes the digital transformation of Chinese enterprises with the help of CiteSpace, a visual analysis software with some theoretical and practical significance.

3. Data sources and research methods

This paper takes Chinese literature on the digital transformation of enterprises as the research object. The literature is searched from the CNKI database with the subject term "digital transformation of enterprises." The journals' sources are SCI, EI, Peking University Core, CSSCI, and CSCD. A total of 255 valid papers were found. The study was analyzed using CiteSpace V6.1 R2, a visual analysis application developed by Prof. Chaomei Chen. The software provides multivariate, time-phased, and dynamic citation analysis. The CiteSpace software provides statistical analysis of literature authors, research institutions, keywords, etc. It draws a relevant map to analyze the development pulse of Chinese enterprises' digital transformation research and explore its hot issues and future development direction.

4. Analysis of the characteristics of literature research

4.1. Time distribution analysis

It can be seen that the annual distribution of articles on the digital transformation of Chinese enterprises from 2011 to 2022 is shown in Figure 1, from which it can be seen that the earliest reports on the digital transformation of Chinese academics were published in 2011, and according to the trend of articles, we can divide the research on the digital transformation of Chinese enterprises into the start-up phase (2011-2019) and the rapid growth phase (2020-present).

Starting phase (2011-2019): the number of publications in the year of digital transformation of Chinese enterprises is low. No relevant literature was published in individual years. The search reveals that the literature published from 2011-2016 studied publishing enterprises. With the innovation and popularity of digital publishing technology, the total output value of digital publishing in China exceeded 100 billion RMB in 2010, with a growth rate of nearly or more than 50% for five consecutive years. The integration between traditional publishing enterprises, digital technologies, and Internet technologies has been strengthened to open digital transformation. 2018-2019, the digital transformation of enterprises gradually extended to traditional industries (refining, oil, gas, etc.), foreign trade enterprises, etc.

Rapid growth phase (2020-present): With a series of policies promulgated by the Chinese government to promote the digital transformation of enterprises, the academic community's attention to this issue has been climbing. The number of publications is increasing. 2018 "Implementation Guide for Promoting Enterprises to the Cloud (2018-2020)" aims to accelerate R&D and design services and optimize production control processes through MES, production data, and other systems to the cloud. 2020 "Notice on Accelerating the Digital Transformation of State-owned Enterprises" and 2021 "Notice on Accelerating the Integration of Two Central Enterprises and Digital Transformation Strategic Cooperation Agreement" instructed the digital transformation of SOEs and cen-

tral enterprises. With the implementation of relevant policies, the digital transformation of enterprises is in full swing in China, and academic research related to it has become a hot topic.



Figure 1. distribution of the annual number of articles issued (2011-2022)

4.2. Analysis of core authors

Figure 2 is the author co-occurrence mapping, from Figure 2 can be seen: there are 113 authors, the authors with more articles are Xiang Ziwei (13 articles), Song Chang (12 articles), Meng Xiangyu (12 articles), Lu Yanqiu (12 articles); the authors with more than ten articles (including ten articles) are 19 in total, which shows that the scholars have in-depth and solid research in the digital transformation of enterprises; according to Price's law $M = 0.749 \times \sqrt{Nmax}$ to determine the core authors in this field, and $M \approx 3.3$, which shows that the authors with more than four articles are the core authors, totaling 30; the network density value of the graph is 0.0066, which shows that the cooperation between authors is not close, and a more complex cooperation relationship has not been formed, and most authors are still mainly independent.

4.3. Analysis of main institutions

Figure 3 shows the institutional co-occurrence mapping, from which it can be seen that: there are 118 issuing institutions for the digital transformation of Chinese enterprises, and the top issuing institutions are Tsinghua University School of Economics and Management (33 articles), Jilin University School of Business and Management (26 articles), and Shihezi University School of Economics and Management (24 articles); universities featuring economic management are the main force of issuing papers, respectively, with Tsinghua University School of Economics and Management and Peking University Guanghua School of Management form a more complex cooperative network as the core, but the network density value of the map is 0.0093, which indicates that the collaborative relationship between institutions is not close and mostly independent research.





Figure 3. institutions co-occurrence network

4.4. Analysis of research hotspots

The keywords are highly condensed and can accurately describe the article's theme. Figure 4 shows the keyword co-occurrence mapping of the digital transformation of Chinese enterprises. In the figure, the terms "digital economy," "big data," and "high-quality development" large nodes are more extensive, which indicates that they appear more frequently and are hot issues in the study of the digital transformation of enterprises. According to the statistics, there are 30 keywords with word frequency higher than ten times, which indicates that the current research on the digital transformation of enter-

NO.	Word Frequency	Betweenness centrality	Keywords
1	70	0.9	digital economy
2	25	0.11	big data
3	20	0.61	high-quality development
4	16	0.19	digital technology
5	15	0.15	enterprise innovation
6	14	0	digital capability
7	13	0	data governance
8	13	0.07	enterprise digitization
9	13	0.11	industrial internet
10	13	0.19	business environment

Fable 1.	High	frequency	keywords
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prises in China is more solid. Betweenness centrality refers to the number of times a node acts as the shortest bridge between two other nodes, and nodes with high Betweenness centrality are more critical. Tables 1 and 2 show the keywords with high word frequency and intermediary centrality, excluding the retrieved keywords. From the table, it can be seen that the word frequency of keywords with high intermediary centrality is low. Excluding the search keywords, words such as "innovation-driven," "high-quality development," and "digital finance " have high centrality, indicating that these keywords play an essential mediating role in the study of enterprise digital transformation.



Figure 4. Keywords Co-occurrence network

5. Research evolution and trend analysis

Keywords time zone mapping can show the knowledge evolution process of a research field from a macro perspective, showing the influence of literature update and interactiv-

NO.	Betweenness centrality	Word Frequency	Keywords
1	0.91	11	innovation driven
2	0.9	70	digital economy
3	0.61	20	high-quality development
4	0.47	2	capital market
5	0.46	12	digital finance
6	0.25	6	text recognition
7	0.21	2	information disclosure
8	0.21	2	spillover effect
9	0.19	16	digital technology
10	0.19	13	business environment

Table 2. High Betweenness centrality keywords

ity, thus intuitively reflecting the changing trend of research hotspots, as seen in Figure 5:

From 2011 to 2016, digital economy, digital technology, digital capability, and digital finance gradually came into the public view, and publishing enterprises took the lead in digital transformation. The Internet, globalization, and excessive competition have reshaped the market, and the wave of the digital revolution has brought about rapid and profound social changes. Companies have started to change their ways of doing business. The "digital economy" has bred new consumption and production models, bringing challenges and opportunities for businesses. Publishing companies have taken the lead in digital transformation, and several scholars have made case studies on the digital transformation of publishing companies, providing references for the digital transformation of other types of enterprises.

From 2017 to 2020, "intelligent refinery," "intelligent supply chain," and "intelligent manufacturing enterprise" have become research hotspots. The 13th Five-Year National Informatization Plan puts forward the specific development goal of "Digital China," and new digital technologies such as cloud computing, big data, artificial intelligence, and blockchain are widely used. In December 2016, the State Council formally issued the "13th Five-Year Plan for National Informatization", which put forward the specific development goals of "Digital China," and the construction of digital China has become a common goal for all industries. Refining enterprises, oil and gas enterprises, manufacturing enterprises, etc., have started the digital transformation. Academic research has also been carried out comprehensively.

From 2021 to 2022, "digital innovation" and "state-owned enterprise" will become research hotspots. Under the new development pattern of the double cycle, the digital transformation of enterprises becomes a critical way to adapt to domestic and international environmental changes and cope with the global epidemic. The deep application of digital technology in various industries has become an essential driving factor for economic growth [12]. In the context of digital economy strategy, multiple enterprises, such as the military industry, manufacturing industry, foreign trade, logistics, and garments, have started digital transformation. The advent of the digital economy era has made the traditional innovation management theory face significant challenges. As the mainstream innovation paradigm, digital innovation is a vital force in promoting the digital transformation of enterprises [13]. State-owned enterprises (SOEs), which are related to the national economy and people's livelihood, are the front-runners in promoting China's

digitalization and intelligent upgrading and play a pivotal role in building new digital infrastructure and constructing a digital economic operation system [14]. At this stage, Chinese academics have researched the digital transformation of SOEs and central enterprises.



Figure 5. The Timezone of Keywords

6. Conclusion

In this paper, we used the visual analysis software CiteSpace to visually analyze the literature on the digital transformation of enterprises in the CNKI database. A mapping of authors, institutions, keywords, and timezone was drawn. The distribution and research trends in the digital transformation of Chinese enterprises were sorted out through the mapping, and the following are conclusions.

6.1. Time distribution

From the distribution of publication time: Chinese enterprise digital transformation research started in 2011. From 2011 to the present, Chinese enterprise digital transformation has experienced the process of "exploration" to "rapid development". The number of publications from 2011 to 2019 is relatively small and belongs to the initial stage. In 2020, the new pneumonia epidemic swept the world and pressed the accelerating button of digital transformation in society, forcing enterprises to start a digital transformation. Transformation to gain room for growth, and research related to it soars.

6.2. Authors and institutions

There are 113 core authors in the field of digital transformation of Chinese enterprises, among which the total number of authors with more than 10 articles (including 10 ar-

ticles) is 19. The cooperation among authors is not yet close, and only a few authors have formed cooperative relationships with each other. Universities featuring economic management are the main contributors, and the management schools of each university have the most publications, with independent research among institutions, and only some institutions have formed more complex cooperation networks.

6.3. Research trends

The publishing industry took the lead and started the digital transformation first. Oil and gas enterprises, refining and chemical enterprises followed and began a digital transformation. And then gradually, involving all walks of life, insurance enterprises, industrial enterprises, foreign trade enterprises, military enterprises, manufacturing enterprises, logistics enterprises, clothing enterprises, etc., began a digital transformation. With the government's attention to the digital transformation of state-owned enterprises, state-owned enterprises have also opened digital transformation.

6.4. Future research direction

Firstly, the digital transformation of enterprises is accelerating, while the digital transformation of state-owned enterprises is relatively slow. According to the research data for 60 central enterprises, 50.4% of respondents believe they are currently at the early stage of transformation and have yet to achieve noticeable results. In contrast, 23.6% of respondents said that the change has encountered obstacles and is trying to find a breakthrough (Tencent Research Institute, 2021) [15].2022 The Guidance on Accelerating the Construction of World-Class Financial Management System in Central Enterprises points out that improving central enterprises intelligent and forward-looking financial digital intelligence system. From this, it can be seen that Chinese enterprises face difficulties in digital transformation and numerous problems need to be solved. Future research can to the field of digital transformation of SOEs and central enterprises.

Secondly, among the enterprises that have carried out digital transformation, industrial enterprises have the highest percentage, followed by service enterprises, and agricultural enterprises have the lowest percentage [11]. The digital economy penetration rates of agriculture, industry, and service industry are 8.9%, 21%, and 40.7%, respectively, which are about 1:2:4. The 14th Five-Year Plan for Digital Economy Development points out that the digitalization of agriculture should be comprehensively promoted. Agriculture is the foundation of the national economy and is related to people's livelihood, but its digitalization could be much higher. In the future, China's research will develop along the direction of digital transformation of agriculture.

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