



# Digital transformation of Chinese enterprises: a visual analysis using CiteSpace

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**Abstract.** This paper reviews the extant literature on digital transformation of Chinese enterprises between 2009 and 2023 in the CNKI database. The bibliographic software CiteSpace is employed to aggregate and analyze the sample literature, and conduct in-depth analysis on the key issues, themes, development, trends, and gaps. The results show that the research on the digital transformation of Chinese enterprises has shown an explosive growth. However, the core author group is scattered, and there is a lack of extensive cooperation between the publishing institutions. In general, there is still much room for development in the research on the digital transformation of Chinese enterprises.

**Keywords:** Digital transformation, CiteSpace visual analysis, Bibliometric analysis.

## 1 Introduction

The recent technological evolution with digital intelligence has been profoundly changing the industry structure and patterns of economic development, particularly with emerging technologies such as cloud computing, big data, and artificial intelligence. As the main body of the real economy, many enterprises are also facing the dilemma of transformation and upgrading such as "dare not transform", "whether can transform" and "how to transform". In China's 14th Five-Year Plan, it is pointed out that "digital transformation drives the transformation of production mode, life-style and governance mode as a whole" and "accelerating digital transformation" are important strategic tasks for building a network power and a digital China, and it has become a general trend to deeply empower traditional enterprises and accelerate the integration of emerging technologies and the real economy to enhance economic efficiency and core competitiveness.

Scholars have conducted a lot of research on the topic of enterprise digital transformation, with a wide range of research fields, diverse research perspectives and abundant output literature. However, as a new technological economic paradigm, digital transformation has rich connotation and rapid update and iteration, and it needs to be comprehensively analyzed from a dynamic and overall strategic perspective. Based on

these, this paper has three contributions to the systematic research using CiteSpace visual knowledge graph. First of all, the visual map can directly reflect the current situation and content of the research on the digital transformation of Chinese enterprises; secondly, by identifying the core authors and the most influential institutions in this field, it is helpful for scholars to retrieve relevant literature ; finally, through keyword co-occurrence and cluster analysis, the development track of research in this field is shown, which helps scholars to understand the evolution of this field and identify new directions.

## 2 Research methods and data sources

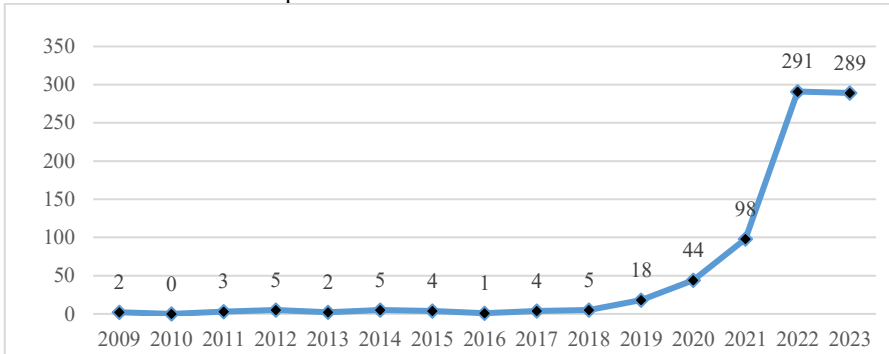
CiteSpace is a bibliometric software used for literature data mining, co-citation network visualization and information analysis. By capturing, reconstructing, measuring, statistical analysis and visualization of information units in literature, the hidden internal relationships and pattern rules can be mined <sup>[1]</sup>. This paper intends to use the CiteSpace visualization software with version 6.2.R2 to quantitatively analyze and visualize the hot topics and evolution trends in the field of digital transformation of Chinese enterprises, so as to show the knowledge panorama of domestic digital transformation research. The specific operation is as follows: Select CNKI database plate as the main source of literature, and set the search time span to January 1, 2009 - August 30, 2023. It mainly generates visual graphs such as the number of publications, co-authors and institutional networks, keyword co-occurrence networks, keyword emergence networks, topic evolution and hot topics clustering. In order to ensure the comprehensiveness and accuracy of the data, the topic retrieval format is set as: Subject word = "Enterprise digital transformation", source category was set as CSSCI, literature type was Chinese journals, a total of 1356 results were obtained. On this basis, further manual screening was conducted, and 771 results were selected as samples for quantitative analysis after literatures with poor relevance such as news reports, academic conferences, and book reviews were excluded.

## 3 Literature feature analysis

### 3.1 Publication trend

As shown in Fig. 1, the rapid development and in-depth promotion of the digital transformation of Chinese enterprises in the past decade have attracted the attention of experts and scholars, and the relevant literature is increasing day by day. The period of study can be generally divided into stages based on the number of published articles. From 2009 to 2018, the number of core literature on enterprise digital transformation research was relatively small and fluctuated in a small range. From 2019 to 2022, the number of papers published exceeded 291. In the first three quarters of 2023 alone, the number of publications was almost the same as the previous year. It can be seen that the in-depth promotion of digital transformation within enterprises has also increased

the exposure and attention of scholars in this field, and the quality and depth of relevant core literature have been improved.



**Fig. 1.** Number of publications on digital transformation of enterprises in CNKI, 2009-2023

### 3.2 Author and institutional analysis

#### Author cooperation network.

In the process of studying the co-authorship network, the node selects the author, the other keeps the default setting, runs CiteSpace, and makes a statistical analysis of the authors in this field, the map we obtained is shown in Fig. 2. According to statistics, 771 core literatures contain 224 nodes, 99 nodes are connected, and the network density is 0.004. The nodes in the figure represent the authors, and the lines between the nodes represent the cooperation between the authors. The different colors of the nodes and the lines represent the articles published in different years. As shown in the legend in the lower left corner, the red is 2023, decreasing in turn. The authors with names in the figure indicate that they have cooperated at least twice in one year, and the remaining scatters and line segments indicate that there is only one cooperation. From the map in Fig. 2, there are scattered points, line segments and triangles, indicating that the cooperation among authors in this field is not close enough, showing loose distribution characteristics, and there are relatively more cooperation among 2-3 people, but more scholars who have published papers independently. In the cooperation network, the research team represented by scholar Wu F has the largest cooperation network, forming an economics research group that has begun to take shape [2]. It mainly innovatively uses text recognition method to measure the intensity of enterprises' digital transformation, and combines empirical analysis to analyze the impact mechanism of digital transformation on capital market stock liquidity, financing cost and main business performance. The second is the small research network composed by Wang B, Yang SL, Sun XB, Song TB and other scholars, which mainly studies the digital transformation of enterprises and the interaction of internal and external factors of enterprises, and has not yet formed a scale [3]. Based on this analysis, the researchers of enterprise digital transformation in China are relatively independent, and there are few academic cooperation and exchanges between them. The core author is a scholar with great output and influence in

a certain research field. Price's law  $M = 0.794\sqrt{N_{max}}$  can be used to explore the situation of authors with high productivity. Among the literature samples selected in this paper, Wu F,  $N_{max} = 18$ , has published the most papers. Authors with price value  $M=3.37$  (integer 4) are the key authors in the field of enterprise digital transformation research. There are 10 core authors who meet the conditions, and the total number of publications is 54, accounting for 7.0% of the total literature, which is far less than 50% of the core group, indicating that there is no stable core author group in the field of enterprise digital transformation in China.



Fig. 2. Author cooperation network of Chinese enterprise digital transformation research<sup>1</sup>

**Institutional cooperation analysis.**

CiteSpace was run to make a statistical analysis of the institutional cooperation network, the results are shown in Fig. 3, and a total of 220 relevant nodes and 135 connections were obtained. Compared with the author cooperation network, the institutional cooperation network shows a close cooperation trend, and the publishing institutions are concentrated in domestic universities and research institutes. The most striking core nodes in the graph are the Institute of Industrial Economics of Chinese Academy of Social Sciences, the Financial Science and Technology Engineering Development Center of Guangdong University of Finance, the School of Economics and Management of Tsinghua University and the Business School of Renmin University of China, with the number of relevant papers reaching 19, 16, 15 and 10 respectively. According to Price's formula,  $M=3.46$  (integer 4) is obtained. There were 49 eligible institutions, with a total of 309 publications, accounting for 40.08% of the total literature, and no core institutional group had been formed. From the local analysis, institutional cooperation shows a trend of regional agglomeration, and the "geo-graphical" cooperation between universities in North China led by Beijing and South China led by Guangzhou is the most obvious, while the cross-college and cross-regional cooperation between universities and institutions in East China, Southwest and Northeast China is relatively small. On the whole, colleges and universities have excellent performance in the study of enter-

<sup>1</sup> The figure is exported by CiteSpace visualization software, similarly hereinafter.

prise digital transformation, have certain foresight and foresight in emerging disciplines, and show a relatively obvious interdisciplinary trend, which is closely related to the excellent teachers and scientific re-search strength of colleges and universities.



Fig. 3. Cooperation network of China's enterprise digital transformation research institutions

### 3.3 Keywords co-occurrence and emergent analysis

Node type select keywords, check pathfinding network algorithm and trim slice network, keep the default Settings for others, run CiteSpace to get keyword co-occurrence graph. There are 260 nodes and 353 connections, and the network density is 0.0105. Intermediary centrality represents the degree to which a node keyword plays an intermediary role in the information transmission of other node keywords. If the index is greater than 0.1, it can be regarded as a key node. According to statistics, keywords with intermediation centrality greater than 0.1 are "digitalization", "digital economy", "manufacturing enterprises", "digital publishing", "innovation efficiency", "human capital", "industrial chain", "enterprise innovation" and "digital technology", indicating that these nine keywords are important keywords in the study of digital transformation, and play a bridge role in connecting other keywords. The intensity of emergence is a factor to measure the change frequency of emergent words, and the stronger the intensity of emergence, the higher the research popularity of the keyword in a certain period of time. According to statistics, the five keywords with the strongest emergence intensity are "small and medium-sized enterprises", "publishing enterprises", "digital economy", "corporate governance" and "digitalization", and the longest emergence span reaches 8 years - "publishing enterprises" and "digital publishing" have been hot topics for scholars to study for a long time. In addition, with the deepening of the research evolution of enterprise digital transformation, scholars' research focus has gradually expanded from conceptual structure and technical means to enterprise innovation management and market competition, which reflects the level of social needs to a certain extent and has certain reference significance for the study of the process of digital transformation.

## 4 Research evolution and cluster analysis

### 4.1 Topic evolution analysis

The research on the evolution of enterprise digital transformation in the academia also reflects the development status of enterprise digital transformation in the industrial industry, as shown in Fig. 4. Based on the analysis of keywords combined with the characteristics of intermediary centrality, it can be found that several important nodes occur in 2009, 2012, 2017, 2019 and 2022 respectively. According to this, the research on enterprise digital transformation from 2009 to 2023 can be di-vided into four stages:

The first phase (2009-2012): Due to changes in domestic market demand and consumer habits, traditional media enterprises faced business model crisis and digital publishing replacement risks, digital publishing, publishing enterprises, digital publishing platforms, media convergence and other concepts emerged one after another, triggering the initial wave, high-frequency words "digital publishing", "publishing enterprises", "media convergence", etc. in the publishing industry. The high-frequency words are "digital publishing", "publishing enterprises", "media convergence" and so on, and the intermediary centrality of "digital publishing" reaches 0.27, which is a real research hotspot. The 2009 Cultural Industry Revitalization Plan explicitly proposed to "actively develop new publishing and distribution methods such as paper audio-books, e-books, mobile phone newspapers, and online publishing", the promulgation of this policy has laid the foundation for the subsequent development of digital technology, and many scholars have begun to explore the transition from traditional publishing to digital publishing in China <sup>[4]</sup>.

The second phase (2013-2016): "Transformation and upgrading", "industrial cluster" and "publishing integration" were the high-frequency words in this period. Digital publishing was in full swing, and media integration entered a period of diversified deepening and development. Scholars began to shift from the macro-theoretical level to the medium and micro level, and the development mode, mechanism path and transformation benefits of publishing enterprises began to attract attention. Scholars propose to construct a platform management system and rebuild business processes to promote the digitization of content resources, distribution methods and marketing models. At the same time, new research themes and keywords such as "smart city" and "network security" began to appear, which played an important role in the diffusion of the subsequent development of the research on digital transformation. The research of scholars gradually extended beyond a single publishing enterprise.

The third phase (2017-2020): With the state's attention to the digital economy and the rapid development of various digital technologies, the digital transformation of the publishing enterprises radiated to small and medium-sized enterprises and manufacturing enterprises, and the concepts of "digital transformation" and "digital economy" were formally put forward<sup>[5]</sup>, and scholars are mostly based on China's national conditions, combining big data, mobile Internet and cloud computing to explain the necessity of digital transformation, and the content of the study ranges from industrial transformation and market competition at the macro level to the causes of the transformation within the enterprise at the micro level, paths, business model change, total factor

productivity, etc. Among the many keywords, "digital economy" is the most important one, and "digital transformation" is the most important one. Among the many keywords, "innovation" is also an important research element, enterprise innovation is considered to be the internal demand of enterprises to realize digital transformation, and digital transformation is the external motive to promote enterprise innovation [6][7].

The fourth phase (2021-present) : Both the outline of the 14th Five-Year Plan and the report of the 20th National Congress of the Party clearly point out that we should accelerate the construction of digital China, and the digital transformation of Chinese enterprises has blossomed at all points, from focusing on crude topic research and broad, generally connected content to in-depth exploration of vertical sectors, and the research content has been transformed from concepts to technical practices and application scenarios, taking into account enterprise practices and social needs. The widespread application of technological tools such as artificial intelligence and big data has promoted the flourishing development of various industries [8]. At the micro level, the development mode of the enterprise and the characteristics of the industry determine different innovation requirements, and the improvement factors are greatly increased [9]. At this stage of enterprises subject to digital transformation, the transformation methods and transformation factors and other related research have been very deeply excavated and other topics have been hotly studied [10].

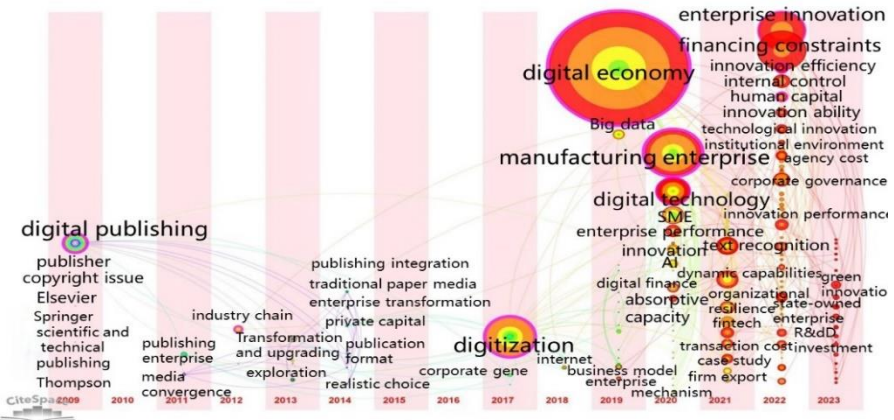


Fig. 4. Evolution map of keyword co-presence area in China's digital transformation research

## 4.2 Cluster analysis

Through the cluster analysis of the keyword co-occurrence network, we explore the structure related to the digital transformation of enterprises in China, and adopt the LLR algorithm. The total number of nodes in the cluster graph is 260, and the number of node connections is 353. The module value of the clustering result ( $Q=0.7462$ ) is much higher than 0.3, indicating that the cluster structure has reached a significant level. The average contour value ( $S=0.9079$ ) is greater than 0.5, indicating that the clustering structure is reasonable and effective. As shown in Fig. 5, the clustering map obtained is divided into 9 clustering modules, in which the smaller the category number, the

larger the category size, that is, the more keywords under the category. The largest category is Cluster 0 digital economy, followed by Cluster 1 manufacturing enterprise; Cluster 2 financing constraints; Cluster 3 digitalization; Cluster 4 dynamic capability; Cluster 5 publishing enterprise; Cluster 6 enterprise innovation; Cluster 7 innovation ability; Cluster 8 publishing form. The overlap between the clustering plates indicates that the elements are closely connected. It can be seen from the figure that the clustering of research topics in this field is quite closely connected.

Cluster 0 digital economy and cluster 3 digitalization are the largest nodes in the cluster, mainly related to big data, artificial intelligence, intelligent services, enterprise performance, technical support and group analytics, with a focus on innovations in the technological performance of the digital economy and the application of models, which is mainly represented by this part of the technology base. The cluster 1 manufacturing enterprise is mainly connected with the keywords of innovation, indicator system, data elements, business model and influence factors, etc. Improve competitiveness. In cluster 2 financing constraints, the largest node is financing constraints, linking keywords such as agency costs, corporate risk-taking, corporate governance, internal control, tax avoidance, etc. Cluster 4 dynamic capabilities is also an important cluster, which mainly includes keyword text analysis, enterprise innovation performance, role mechanism, high-tech enterprises and other keywords. The topic of dynamic capabilities has been actively discussed in recent years, and although each topic term has its own focus, its meaning is actually closely related. Cluster 5 publishing companies and cluster 8 publishing form are connected with keywords such as digital publishing, media integration, all media, scientific journals, traditional journals, etc., indicating the problems existing in the transformation of digital publishing in China and the modes and solutions that should be explored. Cluster 6 enterprise innovation and cluster 7 innovation ability revolve around keywords such as digital finance, transaction costs, investment efficiency, cohort effects, government subsidies, business models, production methods, and organizational methods. The focus of this cluster is to reflect innovation as a key element in a firm's digital transformation, and the two are typically mutually influential and mutually facilitating.



**Fig. 5.** Clustering map of hot topics of digital transformation research in China



## 5 Conclusions

Based on the literature data related to enterprise digital transformation in the core periodical set of CNKI database from 2011 to 2023, this paper employed the visual analysis software CiteSpace to conduct a detailed exploration of the development trend and hotspot clustering of enterprise digital transformation in China. On the whole, the research on digital transformation of Chinese enterprises has firstly shown flourishing, especially in the past five years, it has received unprecedented attention, and the research subject is rich, the research Angle is diversified, and the re-search content is comprehensive. With the country's growing attention, digital governance, digital government and digital China construction will continue to show a vigorous trend. Secondly, in the process of studying the digital transformation of specific enterprises, scholars generally pay attention to relevant concepts, impact mechanism, motivation, digital technology, innovation performance and business model. In terms of research subjects, Chinese scholars mostly focus on manufacturing enterprises, small and medium-sized enterprises and retail enterprises, etc. In industry research, the digital transformation of enterprises specifically in the publishing industry shows volatile development, and new research hotspots have emerged in recent years. Thirdly, the research trend of enterprise digital transformation and the development of digital technology have a high correlation with national policies and situations at the national level. The national and government policies and concerns have a profound impact on the direction and development trend of China's enterprises' digital transformation, and digital transformation and upgrading will continue to be combined with blockchain, the new normal, high-quality development and so on to become a research hotspot, while helping the coordinated development of digital government and digital China construction. Finally, according to the keyword emergence graph, future research on digital transformation can focus on the following dimensions: at the micro-enterprise main level, artificial intelligence, operational efficiency, green innovation, enterprise management and text analysis are the key points; at the government and national level, digital finance, industrial competition, information disclosure, innovation-driven development and other factors are worthy of in-depth exploration. This can boost the high-quality development of China's digital economy on the basis of improving the current research theory<sup>[11]</sup>.

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