

# A Review of Digital Economy Enabling the Transformation and Upgrading of China's Manufacturing Industry

## —Bibliometric Analysis Based on CiteSpace

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### ABSTRACT

This paper examines the relevant literature on the transformation and upgrading of China's manufacturing industry enabled by digital economy, using Citespace visualization software. The analysis shows that the hotspots of research focus on digitalization, artificial intelligence, and industrial transformation. The research emphasizes digital economy and manufacturing digitalization, manufacturing innovation, allocation of manufacturing resources, and high-quality development of the manufacturing industry. Future research can focus on practical case studies and complete system evaluations to further enrich our understanding of these topics.

### KEYWORDS

Digital economy; Digital transformation and upgrading; Visual Analytics; Citespace

## 1. INTRODUCTION

In the mid to late 20th century, with the economic globalization and the increasing progress of science and technology, mankind gradually entered the digital era, and the digital economy gradually developed. Tapscott first proposes the concept of digital economy [1], which has subsequently been widely and deeply researched and discussed by academics. At the end of the 20th century and the beginning of the 21st century, with the rise of the Internet and the continuous development of information technology, the Chinese government gradually realized the importance of digital economy to economic growth and social development, and established the Network Economy Research Center to study the development of digital economy and policy formulation. As time goes by, digital economy has become one of the important pillar of China's economy, and various industries are actively exploring the opportunities and challenges of digital development. As a supporting industry for economic development, the transformation and upgrading of the manufacturing industry has become an important road for the future development of the manufacturing industry. In the context of digital economy, how to promote the core competitiveness of manufacturing industry, cultivate new growth points and realize the transformation and upgrading of manufacturing industry has become an important research issue. In recent years, Chinese scholars have made great progress in empowering the transformation and upgrading of the manufacturing industry with digital economy, and the research content has been continuously expanded and deepened. With the accumulation of research results, it is urgent to summarize and analyze related research, summarize the literature distribution and research frontier, and look forward to the future research direction. Based on this, this paper uses CiteSpace software to visualize and analyze the

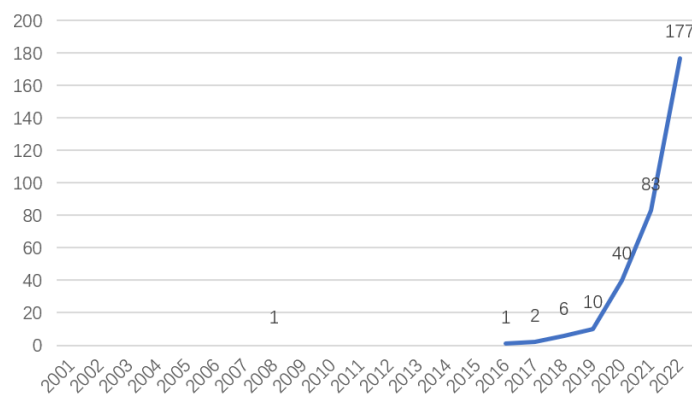
literature related to digital economy empowering the transformation and upgrading of China's manufacturing industry. By combing the publication volume, keyword distribution and clustering of relevant Chinese literature, this article summarizes the current research hotspots, research content and development rules, in order to provide a reference for the practical application of digital economy to promote the transformation and upgrading of the manufacturing industry.

## 2. LITERATURE STATISTICS AND ANALYSIS

### 2.1. Methodology and Sample

Taking into account the representativeness and comprehensiveness of the data sample, this paper uses the China National Knowledge Infrastructure (CNKI) database as the literature search source, and the specific data selected is "CSSCI". After setting the topic as "digitization", "digital economy", "manufacturing industry" in the CNKI database and setting the search time to "2002-2022", a total of 325 documents were obtained. All 325 documents were selected and converted to Refworks format and imported into CiteSpace software. After further reading, screening, and sorting of the literature, non-academic literature such as reports, conferences, and news reports, as well as literature on related biased topics were excluded, after de-duplication processing, since there were no relevant literatures from 2002 to 2007, 321 literatures from 2008 to 2022 were retained as the initial samples of this study. Assisted by CiteSpace software, a knowledge graph was obtained by visualizing the literature through algorithm analysis to explore the historical context and future trends of research on the impact of my country's digital economy on manufacturing industry.

### 2.2. Distribution of Publications



**Figure 1.** Annual distribution of publications on research related to digital economy and manufacturing industry in China

The 321 CSSCI papers on the topics of "digital economy" and "manufacturing industry" are sorted by year, as shown in Fig. 1. By dividing the number of publications in different periods, the research on digital economy and manufacturing industry in China in the past 20 years can be divided into three stages. The first stage is from 2008 to 2016, which is the gestation period for research related to digital economy and manufacturing industry in China. During this period, the number of CSSCI papers per year was basically 0, and there was almost no growth trend. The only CSSCI paper was published in 2008, and no related papers were published in the following years. The second stage is from 2016 to 2019, which is the embryonic stage of digital economy and manufacturing industry research in China. In this phase, the annual publication volume of CSSCI papers on the topic of digital economy and manufacturing industry increased, with a slow growth trend of 10 and less articles per year. The third phase is after 2020, which is the period of rapid development of digital economy and manufacturing research in China. At this stage, the annual publication volume of CSSCI papers on digital economy and manufacturing industry showed an explosive growth trend.

### 3. RESEARCH AND TREND ANALYSIS

#### 3.1. Keyword Frequency Analysis

This study conducts a keyword analysis of literature related to digital economy and manufacturing industry, and explores research trends by comparing keywords. We set the time slice to 1 year, take keyword as node types, and comprehensively consider the top 10 effective high-frequency core keywords (see Table 1). The frequency of keywords shows the diversity of research topics. Specifically, digital economy is the highest (147 times), followed by manufacturing industry (42 times), digital technology (12 times), and artificial intelligence (10 times). With a centrality of 1.03, digital economy is essentially co-occurrence with all other keywords, followed by manufacturing industry. In terms of the graph structure, these keywords, together with the other node keywords surrounding them, constitute the hot research topics in the field (see Fig. 2). From the above analysis, it can be seen that scholars pay the most attention to digital economy and manufacturing industry, and their research is inextricably linked with keywords such as digital technology, artificial intelligence, digitization, innovation drive and industrial structure.

**Table 1.** Keyword frequency and centrality statistics (Top 10)

ID	Keywords	Frequency	Centrality
1	Digital economy	147	1.03
2	Manufacturing industry	42	0.09
3	Digital technology	12	0.04
4	Artificial intelligence	10	0.02
5	Digitization	8	0.07
6	Innovateion drive	7	0.02
7	Industrial structure	6	0.03
8	Real economy	5	0.04
9	Industry chain	5	0.02
10	Employment structure	4	0.02

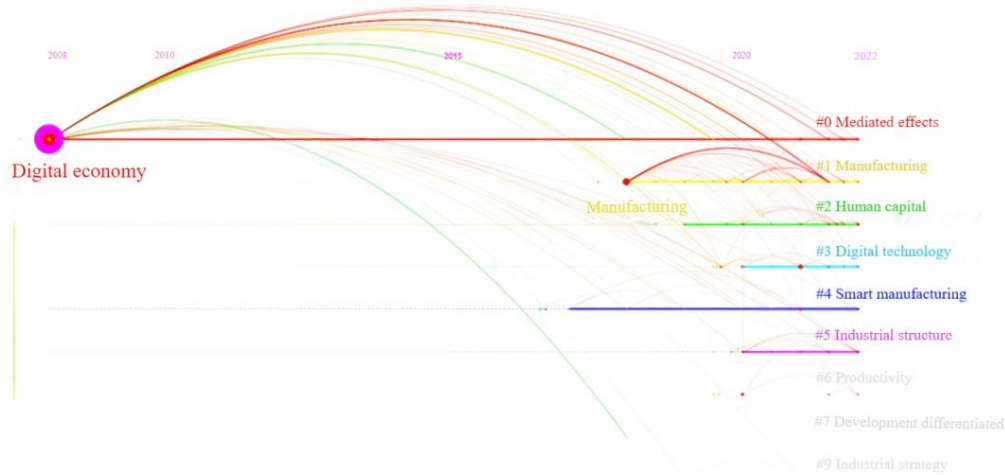


**Figure 2.** 2008-2022 Co-occurrence of keywords in digital economy and manufacturing industry research

#### 3.2. Keyword Cluster Analysis

To further analyze the topic distribution and research hotspots in the research area of digital economy enabling manufacturing transformation and upgrading, CiteSpace software is used to cluster the keywords. The log-likelihood ratio (LLR) algorithm is used to cluster and visualize the keyword

network map to form a keyword clustering map, and a total of 10 clusters are obtained (see Fig. 3). The Modularity Q value is 0.5588, indicating that the network modules of the clustering results are closely related. At the same time, the Mean Silhouette value is 0.9179, which is greater than the critical value of 0.5, indicating that each cluster has a strong connection with this study. Based on the clustering results, combined with the ranking of high-frequency core keywords and relevant literature, it can be seen that China's research on the integration of digital economy and manufacturing industry appeared around 2017, and the related research hotspots mainly focused on human capital, digital technology, intelligent manufacturing, industrial structure, productivity and other fields.



**Figure 3.** Keyword clustering of digital economy and manufacturing industry research

#### 4. ANALYSIS OF RELATED RESEARCH HOTSPOTS

Digital economy is an emerging economic form following the agricultural and industrial economies. It is an economic activity with digital information (including data elements) as the key resources, Internet platform as the main information carrier, digital technology innovation as the driving force, and a series of new models and business formats as the manifestation [2]. With the development of new-generation information technology, consumer Internet is accelerating its extension to industrial Internet, and digital economy is transitioning from the consumer to the manufacturing field. Manufacturing industry is the main battleground of economic development. In the future, the integration of digital economy and manufacturing industry, solving the "pain points" in manufacturing transformation and upgrading are issues worthy of attention [3], [4]. Based on the above analysis, this article divides the relevant hot research on digital economy empowering the transformation and upgrading of manufacturing industry into digital economy and manufacturing digitalization, digital economy and manufacturing innovation, digital economy and manufacturing resource allocation, and digital economy and manufacturing high-quality development.

(1) Digital economy enables the transformation and upgrading of manufacturing industry. The essence of the transformation and upgrading of manufacturing industry driven by digital economy lies in the reshaping of the whole industrial chain of traditional manufacturing industry by using digital technologies such as Internet, big data and artificial intelligence [5]. The integration of digital economy and manufacturing industry is a necessary way to improve the value-added capacity of the system, which has widely promoted the transformation process of manufacturing industry [6], [7]. Research shows that digital economy has an important role in promoting the transformation and upgrading of manufacturing industry, promoting the transformation of manufacturing industry into a capital, technology and knowledge-intensive stage, and the process of digital economy empowering the transformation and upgrading of manufacturing industry is also inseparable from a good development environment. For example, talent attraction, financial development, technological

innovation, transaction costs, industrial upgrading, etc., all play an influential role in the process [8], [9], [10].

(2) The manifestation of digital economy enabling transformation and upgrading of manufacturing industry. Digital economy has made data a new production factor, promoting the transformation and upgrading of manufacturing industry by improving infrastructure, optimizing resource allocation, reducing production costs, driving multi-dimensional integration, improving production methods, optimizing management models, improving technical efficiency, promoting green development, digital industrialization and industrial digitalization [11], [12], [13]. Digital technology improves production and business processes, provides strong momentum for manufacturing transformation, and improves enterprise productivity. Digital technology also breaks down spatial and temporal constraints, ensures the flow of information, strengthens organizational exchanges, expands the boundaries of organizational division of labor, and strengthens regional coordination, thus providing a wide market space for manufacturing enterprises to pursue greater value gains [5], [14]. This enhances the digitalization of manufacturing, promotes industrial innovation, and improves the efficiency of resource allocation.

(3) Digital economy and manufacturing digitalization. Digital transformation has become a prerequisite for sustainable competitive advantage in manufacturing [15]. For manufacturing companies, seizing the opportunity for timely data empowerment and digital transformation is an important way to improve competitiveness [16]. Digital economy enables the manufacturing industry to transform towards digitalization and informatization, and changes the operating model of traditional manufacturing. This accelerates the manufacturing industry towards intelligent decision-making, giving rise to new manufacturing models such as intelligent manufacturing, boosting the upgrading of industrial structure [17], and realizing the reconfiguration of the manufacturing industry chain and the globalization of the value chain [18], [19]. Research on the digitalization of manufacturing industry can be divided into two categories. First, manufacturing datafication. It lowers the technological threshold by integrating the manufacturing process with digital technology, making complex manufacturing techniques relatively simple and standardized, and greatly reducing the difficulty of R&D and learning required in manufacturing [20]. This promotes the transformation of low-value-added traditional industries to high-value-added medium- and high-end industries [21], realizes the digital transformation from traditional manufacturing, and pushes forward the high-end of the industrial structure and value chain [22]. Second, service digitalization. Digital economy makes it easier and more effective for manufacturing enterprises to access data, easier to capture consumer behavior characteristics and personality needs, and realize the value added of various stakeholders. This has encouraged manufacturing to create new service businesses and core competencies in a digital environment [23], [24].

(4) Digital economy and manufacturing innovation. Li Ying & He Jun argue that the development of digital economy empowers manufacturing innovation from an all-round perspective [25], realizing a shift in the internal mechanism and operation logic of manufacturing industry innovation. First, digital technology creates an open innovation environment, promotes the reorganization of production factors, and breaks the original industrial boundaries. This broadens the manufacturing ecological network, improves the efficiency of manufacturing technology innovation, accelerates the promotion of manufacturing innovation, and enhances the ability of manufacturing innovation and upgrading [26]. Digital economy can also achieve cross-regional sharing and learning through digital technology, allowing manufacturing technology innovation to spill over geographically to neighboring regions [27], narrowing the innovation gap between industries and facilitating the coordinated development of innovation. Second, digital economy moves away from the traditional development model by promoting green technology innovation [28], and increasing the total factor productivity [29], [30], [31], [32]. This enables manufacturing companies to reduce pollution emissions and promote green transformation and upgrading [33], [34], [35].

(5) Digital economy and manufacturing resource allocation. Digital economy with data as the core production factor breaks the constraints of the traditional factor market, promotes the optimal allocation of production factors, enhances the cooperation level among factors, strengthens market competition, and optimizes industrial distribution [36], [37], [38]. This reduces the risk of multi-dimensional information asymmetry, helps reduce corporate manufacturing and operating costs, improves transaction efficiency, reduces resource mismatch and waste, brings about value reshaping of production factors, improves resource allocation efficiency [26], [38], and forms a driving force for the transformation and upgrading of the manufacturing industry [14].

(6) Digital economy and manufacturing high-quality development. Digital economy provides an important breakthrough for the high-quality development of manufacturing industry [39]. Digital economy promotes the gathering of scientific and technological talents and financial development, realizes precise matching, promotes the integration of traditional manufacturing industry chain and innovation chain [40]. Digital economy can also indirectly increase the total factor productivity of the manufacturing industry by improving technological efficiency, upgrading human capital, stimulating entrepreneurial vitality, and promoting industrial upgrading and technological innovation [10], [42], [43], and drive the transformation of the manufacturing industry to high-quality development.

## 5. CONCLUSION AND FUTURE RESEARCH DIRECTION

The results show that Chinese scholars have formed a relatively complete research system on how digital economy empowers the transformation and upgrading of manufacturing industry. Among them, "digital economy", "manufacturing industry", "transformation and upgrading", "digital technology", "industrial structure", "artificial intelligence" and so on are the core keywords. Meanwhile, the research mainly covers digital transformation, manufacturing innovation, industrial upgrading and enterprise transformation. Current research hotspots and trends include the deep integration of digital economy and manufacturing, the impact of digital transformation on enterprises and industries, and the application and development of intelligent manufacturing technologies. Based on the analysis, this paper characterizes the research on digital economy-enabled transformation and upgrading of the manufacturing industry into the following two points. Firstly, the research can keep pace with the development of the times and has certain foresight. Second, the research methods are constantly deepened, and the causal relationship can be analyzed by using qualitative and quantitative methods.

Although current research has yielded rich results, there are still some shortcomings in the existing studies that require further in-depth research. First, specific practical cases. Many studies have already conducted some theoretical discussions on digital economy-enabled transformation and upgrading of the manufacturing industry, and proposed some new ideas and methods. However, from the perspective of practical cases, there is a relative lack of successful typical cases, especially in SMEs. Therefore, future related research should pay more attention to enterprise practices and explore paths to meet the development of SMEs. Second, systematic theoretical research. The transformation and upgrading of the manufacturing industry in the digital economy is a complex and systematic project that needs to consider various factors, such as technology, industry, and policy, comprehensively. At this stage, most of the studies tend to start from a single perspective only, and lack of systematic analysis and research, the future should be explored from multiple perspectives.

Third, complete evaluation systems. Digital economy empowers the transformation and upgrading of the manufacturing industry, which requires the establishment of a complete evaluation system to carry out effect evaluation. Current research often remains at the level of proposing theoretical frameworks and methods, lacking quantitative evaluation of actual effects. Therefore, the establishment of a quantitative evaluation system is also one of the future research directions.

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