Article

A Synthetic Review on Enterprise Digital Transformation: A Bibliometric Analysis

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Abstract: The digital transformation of enterprises has become an inevitable trend. Conducting a bibliometric analysis of the literature on the digital transformation of enterprises and exploring the current status of digital transformation will provide valuable references and suggestions for enterprises. Both bibliometric analysis and literature review methods are utilized in this study. Among the bibliometric analysis tools are HistCite and CiteSpace. This study finds that Parida V and *Technology Forecasting and Social Change* are the most prolific authors and journals on enterprise digital transformation, respectively. The USA has the most publications, and Copenhagen Business School is the most influential institution. Three stages are shown by the citation mapping: the budding stage (before 2014), the system formation stage (2015–2019), and the diversified development stage (2020–present). Based on keyword co-occurrence analysis and emergent keyword analysis, this study constructs a conceptual framework for enterprise digital transformation in four aspects: digital technology adoption, digital dynamic capabilities, digital innovation orientation, and digital transformation performance. This study provides a systematic overview of enterprise digital transformation research, establishes a conceptual framework for enterprise digital transformation, and provides certain theoretical insights to steer corresponding practical activities.

Keywords: enterprise digital transformation; bibliometric analysis; conceptual framework

1. Introduction

With the rapid development of technology, digital transformation has become a crucial factor in the sustainable development of firms [1]. Enterprise digital transformation means that enterprises make use of digital technology to carry out comprehensive and in-depth changes to business processes, organizational structure, corporate culture, and so on, in order to improve operational efficiency, innovate business models, and enhance competitive advantage [2,3]. At its core is digital technology, which is a key factor in realizing comprehensive and in-depth enterprise change [4]. Digital technologies include big data, cloud computing, artificial intelligence, the Internet of Things, blockchain, and other emerging technologies. These technologies can provide enterprises with considerable amounts of data and information to help them achieve their goals.

In recent years, the necessity for digital transformation for companies across all industries has become increasingly evident. Studying enterprise digital transformation can provide insights into the challenges and opportunities faced by companies transitioning to a digital model. Research shows that digital transformation has the potential to revolutionize existing business models, create novel sources of revenue, and improve the customer experience [5–7]. The necessity for digital transformation is further highlighted by many studies, which found that firms embracing digitization are more likely to achieve long-term success [8–10]. In other words, there is a close relationship between digital transformation and enterprise sustainable development. Digital transformation helps enterprises to improve resource utilization efficiency, reduce energy consumption, and relieve environmental stress, thus supporting sustainable development. More specifically, digital transformation can

promote enterprises to carry out green technological innovation, improve environmental awareness and social responsibility; promote internal management and organizational change; and improve employee satisfaction and work efficiency. All these will further promote the sustainable development of firms. This shows the significance of enterprise digital transformation for the long-term development of enterprises. Moreover, studying enterprise digital transformation can provide insights into the technology adoption trends and strategies employed by companies [5]. This knowledge can be useful for companies seeking to develop and improve their own digital transformation plans. In conclusion, research on enterprise digital transformation can not only help enterprises to understand the challenges and opportunities more deeply and expand their technical and strategic knowledge, but more importantly, it can provide important references for their long-term sustainable development. Therefore, enterprises should actively learn and draw on existing knowledge about enterprise digital transformation. By continuously optimizing their digital transformation strategies and practices, enterprises will be in a better position to address future risks and opportunities and achieve sustainable development goals.

Although the necessity and potential benefits of enterprise digital transformation have been broadly recognized, how enterprises can successfully carry out digital transformation remains a complex issue. Enterprises need to continuously learn and adapt to new knowledge and technologies in order to realize their own digital transformation. However, it is a challenging task to find valuable information on the digital transformation of enterprises in the vast amount of literature and to distill common problems and solutions from numerous studies. Bibliometric analysis provides a powerful tool to address this issue. Providing a quantitative assessment of research trends and publication patterns can help to pinpoint the most important issues and trends in digital transformation research. Such insights can be valuable for guiding future research and informing business and policy decisions. In this paper, we conducted a bibliometric analysis of publications on enterprise digital transformation using HistCite and CiteSpace to determine the current research status on enterprise digital transformation. This information greatly assisted the literature review. Through in-depth interpretation and summarization of key publications, we tried to propose a framework for enterprise digital transformation research to inform future research and enterprise digital transformation practices. Overall, this study answers the following questions.

- Which authors, articles, journals, institutions, and countries are the most influential in the area of enterprise digital transformation research?
- What stages of development has enterprise digital transformation research gone through?
- What issues have enterprise digital transformation research focused on? What are the current research hotspots?
- What guidance can we provide for future enterprise digital transformation research or practice?

The remaining sections are summarized below. Section 2 demonstrates the study design of this paper. The study methodology, tools, and data collection process are briefly described. Section 3 shows the general findings from the bibliometric analysis and describes an overview of research about corporate digital transformation. Section 4 provides further analysis based on HistCite citation mapping and keyword co-occurrence and emergence mapping. Three phases of corporate digital transformation research and research themes for each phase are sorted out. Based on the results of the above bibliometric analysis and in-depth readings, Section 5 proposes a conceptual framework for enterprise digital transformation to guide future research and practice. Finally, the significance of this work, its limitations, and proposals for future work are elaborated.

2. Materials and Methods

This article employed a bibliometric methodology as it provides a systematic examination of publications to reveal trends, gaps, and emerging topics [11]. Bibliometric analysis helps to gain insights into the research status and to identify influential authors, institutions,

or journals in the area of study [12,13]. Therefore, using the bibliometric method to study enterprise digital transformation is appropriate as it provides a comprehensive view of the research landscape in the field and can facilitate better comprehension of enterprise digital transformation.

2.1. Data Collection

Our sample articles were searched within Web of Science Core Collection. To ensure the comprehensiveness of the data, we used a specialized search with the search formula: TS = (digital transformation OR digital transition) AND TS = (firm$ OR enterprise$ OR business* OR compan* OR corporation$), where "TS" represents the search topic, the symbol "$" represents zero or one character, and the symbol "*" represents any matching group of characters that will be searched. Then, we set the following requirements to cull the sample articles. (1) The time span was from 1985 to 2022. (2) The document category was limited to "Business" or "Management". (3) The literature type was limited to "Article". Finally, 801 articles on the digital transformation of enterprises were considered for bibliometric analysis.

2.2. Bibliometric Tools

We used HistCite and CiteSpace as bibliometric tools. Their versions are HistCite Pro 2.1 and CiteSpace 6.1.R3 64-bit Basic, respectively. HistCite is commonly used for citation analysis, which can quickly map out the development of a research field and target important literature and scholars in a certain research direction. CiteSpace uses visualization to present the structure, pattern, and distribution of scientific knowledge. The more commonly used functions include keyword co-occurrence analysis and keyword emergence analysis [14]. It is widely used to analyze the changes in research hotspots and trends [15–17].

On the one hand, we used HistCite to obtain statistics on the number of annual publications, leading authors, major journals and research institutions, and top countries. Then, we used HistCite to draw a citation mapping to determine the key literature in the research field of firms digital transformation and the relationship between the literature. Through literature reading and combing, we revealed the development stages, themes, theoretical foundations, and research methodologies of this research field. On the other hand, we drew keyword co-occurrence mapping and emergent keyword mapping with the CiteSpace software to present the hotspots and development trend of this research. Finally, we delved into 30 highly cited classical articles and the references cited in these articles to propose a conceptual framework on enterprise digital transformation, thus offering a reference for future research. Figure 1 displays the research process of this paper.
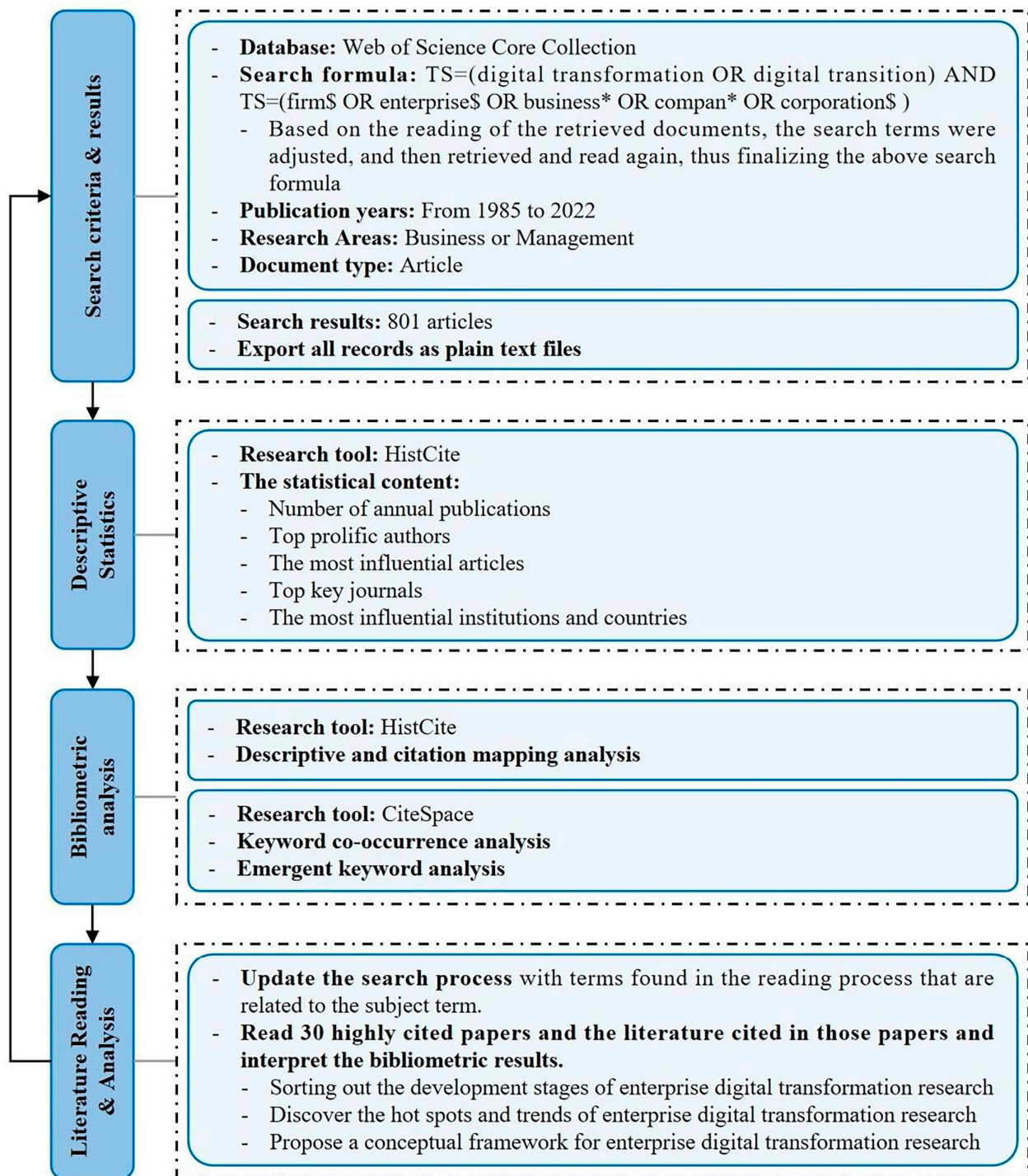
Figure 1. Research methodology of this paper.

3. General Results

In this section, we mainly used HistCite to provide general results on articles about enterprise digital transformation, including annual publication, prolific authors and journals, key articles, and influential countries and institutions.

3.1. Number of Annual Publications

The annual number of publications from 1985 to 2022 is shown in Figure 2. There are three notes in response to Figure 2: First, records (Recs) in the figure indicates the number of publications; second, the year in the figure begins in 1998, indicating that

the sample database of enterprise digital transformation publications that met the search criteria appeared after that time; third, there was no literature in 2002 that met the search criteria for this paper, so the 2002 data are not shown in Figure 2. The research outputs on enterprise digital transformation have steadily increased since 2012 and show a rapid rise after 2018. This indicates that enterprise digital transformation research has been receiving attention from academia in recent years, and the attention received has further increased in the last five years. Possible reasons for this growing trend are the further establishment of the strategic position of digitalization. For example, the European Union established the Digital Europe project in 2018; in 2019, the G20 reaffirmed its commitment to promoting digital transformation. Regional policies influence the direction and volume of academic research.
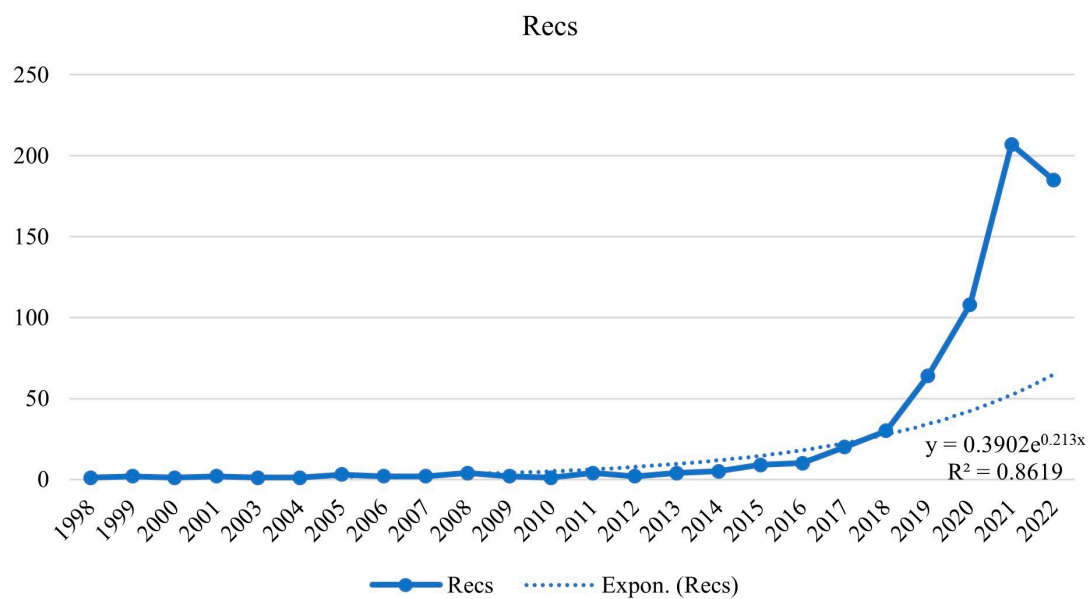

Figure 2. Distribution of sample articles based on year (1985–2022).

3.2. Top Prolific Authors, Influential Articles and Key Journals

The number of publications can reflect the academic status of authors in the relevant fields. In this section, we found the top prolific authors, influential articles, and key journals, based on the output of HistCite.

As shown in Table 1, we ranked authors according to Recs. The scholar with the highest number of publications is Parida, who maintains a close collaboration with Kauffman and Sjodin.

Table 1. Top prolific author of the 2200 authors ranked by Recs.

Author	Number of Authors	Recs
Parida V	1	16
Kauffman RJ	1	7
Del Giudice M, Hess T, Scuotto V, Sjodin D	4	6
Kohtamaki M, Kraus S	2	5
Arias-Perez J, Bresciani S, Candelo E, De Massis A, Endres H, Frank AG, Gebauer H, Ghezzi A, Li F, Li J, Muller JM, Nasiri M, Paiola M, Ritala P, Rossi M, Saunila M, Schiavone F, Secundo G, Sun XB, Ukko J	20	4

Table 2 lists the most influential articles ranked by the local citation score (LCS). In it, LCS indicates the number of times a particular literature has been cited in a local dataset. A high LCS indicates that the paper is more influential in our local citation. LCS/t indicates

the growth rate of the LCS over a given time period, where t indicates the number of years the literature has been published. This metric can help researchers to understand how the citation impact of a particular piece of literature in the field changes over time. The paper written by Warner and Wager [18] is the most prominent research paper in the sample (LCS = 88, LCS/t = 22). This indicates that this paper has established a stable theoretical footing for studies on digital transformation and has been widely accepted by scholars in this academic circle. In addition, we noticed that another paper written by Verhoef et al. [6] had a higher LCS/t score (LCS/t = 31) despite having a lower LCS, which indicates that it is more meaningful for enterprise digital transformation research. The top 10 most-cited articles were almost all published within five years (2017–2022), indicating that the studies were relatively novel.

Table 2. The most influential articles of the 801 articles ranked by LCS.

Title	LCS	LCS/t
Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal	88	22.00
Options for formulating a digital transformation strategy	79	11.29
Digital transformation: A multidisciplinary reflection and research agenda	62	31.00
Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective	45	11.25
Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers	45	7.50
How chief digital officers promote the digital transformation of their companies	43	7.17
How big old companies navigate digital transformation	41	6.83
Digital servitization business models in ecosystems: A theory of the firm	39	9.75
The role of dynamic capabilities in responding to digital disruption: A factor-based study of the newspaper industry	34	4.25
The impact of digital technology on relationships in a business network	32	5.33

Table 3 displays the results of the analysis on journals. In it, TLCS (total local citation score) is a global metric that indicates how much a particular piece of literature has been cited in the entire academic field. As shown in Table 3, we noted that articles on enterprise digital transformation are mainly published in *Technological Forecasting and Social Change*, *Journal of Business Research*, *Industrial Marketing Management*, *Journal of Manufacturing Technology Management*, *IEEE Transactions on Engineering Management*, and other journals. Among them, *Technological Forecasting and Social Change* has the most publications, with a total of 76. Additionally, the sum of publications held by the top five journals takes up 26.5% of the sum of publications, indicating that the publications on corporate digital transformation are concentrated. In addition, the impact factor of the top three journals is much higher than 2.0 and the JCR partition is Q1, which indicates that these three journals have gained high attention and recognition from the academic community.

Table 3. The most influential journals of 163 journals ranked by Recs.

Journal	Recs	Percent	TLCS	Impact Factor (2022)
Technological Forecasting and Social Change	76	9.5	79	12
Journal of Business Research	59	7.4	250	11.3
Industrial Marketing Management	29	3.6	168	10.3
Journal of Manufacturing Technology Management	25	3.1	65	7.6
IEEE Transactions on Engineering Management	23	2.9	4	5.8
Mis Quarterly Executive	22	2.7	257	4.1
Business Horizons	21	2.6	47	7.4
Business Process Management Journal	18	2.2	20	4.1
Journal of Business & Industrial Marketing	18	2.2	8	3.1
Technology Analysis & Strategic Management	16	2.0	0	3.4

3.3. Most Influential Institutions and Countries

We obtained information on highly productive institutions, centrality, and the geographical location of corporate digital transformation research through CiteSpace (Table 4). In terms of Recs, the most prolific institutions are Copenhagen Business School, Politecnico di Milano, and the University of Turin. In terms of centrality, the highest centrality is at Copenhagen Business School. In terms of geographic location, the leading countries in both volume and concentration are largely located in Europe. By comparing the top 10 institutions by number and centrality, we find that only one institution, Copenhagen Business School, is in the top 10 with a centrality of more than 0.1. This indicates that institutions with high paper production do not necessarily have very close cooperation with other institutions, and the research results of each institution are highly related to their own research level.

Table 4. Top ten institutions among 1113 institutions ranked by Recs and centrality.

Recs	Institution	Country	Centrality	Institution	Country
20	Copenhagen Business Sch	Denmark	0.13	Copenhagen Business Sch	Denmark
17	Politecnico	Italy	0.07	Free Univ Bozen Bolzano	Italy
14	Univ Turin	Italy	0.07	Univ Turin	Italy
14	Lulea Univ Technol	Sweden	0.06	Univ Cambridge	UK
13	Univ Vaasa	Finland	0.05	Aarhus University	Denmark
10	Univ Cambridge	UK	0.04	London Business School	UK
9	LUT Univ	Finland	0.04	Politecnico	Italy
9	Univ Milano Bicocca	Italy	0.04	Lulea Univ Technol	Sweden
9	Univ Lancaster	UK	0.04	LUT Univ	Finland
9	Free Univ Bozen Bolzano	Italy	0.04	Zhejiang University	China

To learn about the effect that different countries play in the field of corporate digital transformation study, we utilized CiteSpace to analyze the publication countries of the resulting literature to obtain the high-producing countries and their centrality, as shown in Figure 3.
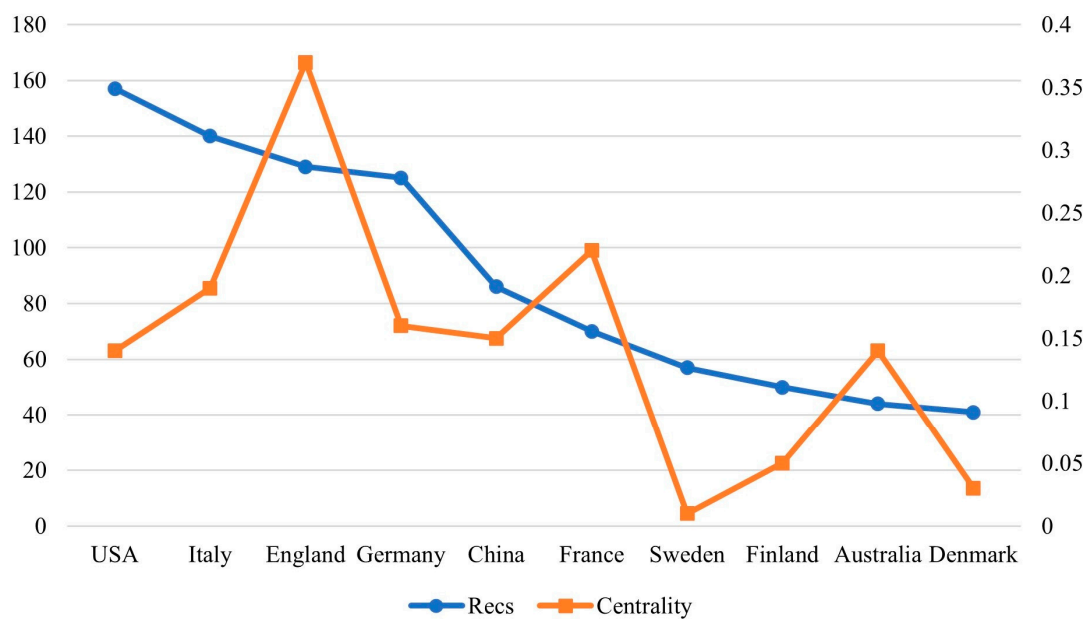

Figure 3. The most influential countries of 69 countries ranked by Recs and centrality.

In terms of Recs, the United States has the most papers in the area of enterprise digital transformation with 157 publications, the next are Italy, the United Kingdom, Germany,

China, and others. The United States ranks first in terms of the number of publications, which may be due to the fact that it started its digital transformation earlier compared to other countries. In 1998, the U.S. Department of Commerce published a thematic report about the digital economy, noting that the development of information technology, the Internet, and e-commerce will generate new digital economic forms. In terms of centrality, nodes with a centrality greater than 0.1 are critical nodes, and critical nodes are usually considered to be likely to trigger changes in the research field. The United States, Italy, the UK, Germany, China, France, and Australia are located on the key nodes, indicating that these seven countries have an influential position in driving the evolution of the field.

4. Bibliometric Analysis

4.1. HistCite Citation Mapping

Citations were visualized through HistCite. Considering the clarity of the graph, the 30 most cited papers (LCS > 30) were included in the analysis. The citation mapping is shown in Figure 4. Each node in the graph represents a piece of literature, and the larger the size of the node, the more times the piece of literature has been cited. The numbers inside the nodes are the literature numbers automatically generated by the system, and the nodes pointed to by arrows represent the other literature cited by a piece of literature in this database. The figure includes 30 nodes and 46 links, and it can be seen that the overall international research themes of corporate digital transformation are more closely connected and there is also a strong cross-citation relationship.

The lineage of enterprise digital transformation research over the last 40 years can be clearly identified in Figure 4:
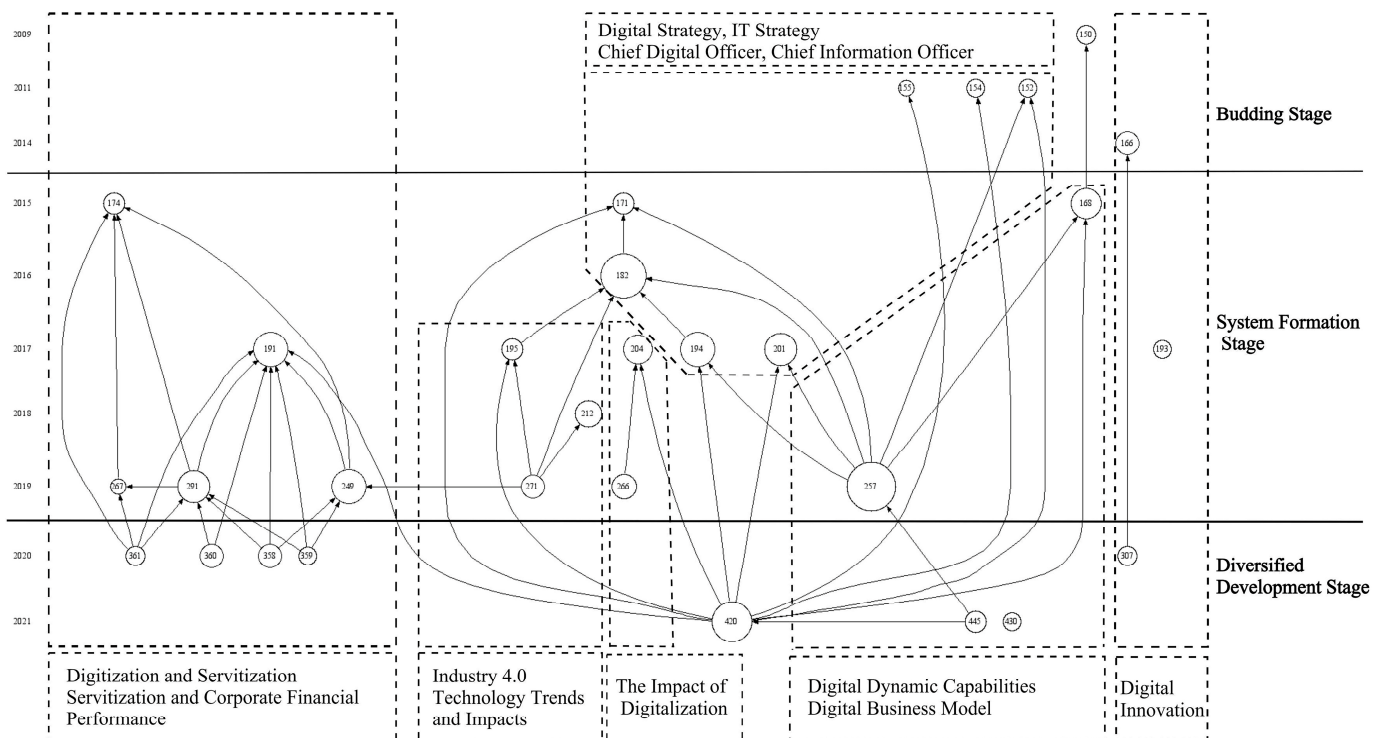

Figure 4. HistCite citation mapping on enterprise digital transformation.

4.1.1. Budding Stage (1985–2014)

The literature node before 2009 shows a gap, indicating that there was no highly cited literature before, and the literature was still in the budding stage of corporate digital transformation study. The earliest node in the past 40 years appeared in 2009 (#150) [19]. The paper extends Christensen's theory of disruptive technology and uses Kodak as an example

of how companies can respond to the challenges posed by transformative technologies. The study points out that technology has the potential to transform industries by creating new products and services, but that a lack of digitally minded people, a rigid organizational culture, and bureaucratic structures can prevent companies from responding quickly to new technologies.

Between 2009 and 2014, four citation nodes also appeared (#152, #154, #155, #166). Liu, et al. [20] combined resource matching theory (resource and capability) and a strategic matching perspective (internal and external) to propose a resource matching framework for digital transformation (#152). Paper No.154 and 155 both focused on the impact of leaders as companies engage in digital transformation practices. Kohli and Johnson [21] combed the actions of the Chief Information Officer (CIO) and Chief Executive Officer (CEO) in the digital transformation of Encana Oil & Gas (the USA) Co., Ltd. (Denver, CO, USA) (#154). The paper summarized the experience of Encana's digital transformation, such as embedding digital technology into the operation process, actively outsourcing non-core IT functions, so as to put forward suggestions on enterprise digital transformation in late-comer industries. CIOs in companies in late-stage industries can close the expectation gap between the IS function and the business by addressing three factors: First, focusing on the IT foundation of cost, reliability, and infrastructure development; second, demonstrating the business knowledge of the CIO and IS function and their ability to meet business needs; and third, influencing those business leaders who are IT-savvy. Hansen, et al. [22] proposed a participatory process model to help information systems and business leaders jointly discuss responses to changes in the competitive and technological environment and adapt to digital transformation (#155). Paper No. 166 is "Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum" [23]. Although its primary purpose is to design a core curriculum, the conceptualization of digital innovation mentioned therein fulfills a key role in digital studies.

Overall, the theoretical foundations of corporate digital transformation research in this period include disruptive technology theory, resource matching theory, and strategic matching theory. Some studies explain the strategic dimensions of digital transformation, the concept of digital innovation, and most of them emphasize the impact of organizational rigidity or path dependence (#150, #152), employee mindset (#150, #152), and synergy (#152, #154, #155) on the digital transformation of enterprises.

4.1.2. System Formation Stage (2015–2019)

A large number of highly cited references emerged in this phase, and the research on enterprise digital transformation gradually formed a system. As can be seen from Figure 4, thirty highly cited references are mainly divided into three major parts, each of which is independent of the other. By combing the references, we can find that these three parts have studied digitalization and servitization, the antecedents–processes–results of enterprise digital transformation, and digital innovation.

The literature in the left half of Figure 4 focuses on the digitization and servitization of manufacturing firms, including the integration of digitization and servitization, and servitization and financial performance. Lerch and Gotsch [24] focused on the digitization of product–service systems against the background of digitalization and servitization convergence (#174). The study showed that a new digital product service system (PSS) can be created by bundling digital systems with product services. Such a digital PSS is intelligent and therefore has the potential to significantly improve efficiency and performance, and in the long run it will help to increase the overall innovation activity of the company. Coreynen, et al. [25] also focused on digitization and servitization (#191). The paper discussed how companies can improve their service offerings through digitization, identifying different dynamic degrees of digitally enhanced resource allocation that support different service-oriented paths for customer-oriented processes. Referring to Paper No. 174 and 191, Frank, et al. [26] examined the relationship between product company servitization and Industry 4.0 in light of the business model innovation (BMI) perspective (#249).

The study has shown that servitization focuses on the addition of value to the customer, whereas Industry 4.0 centers on the addition of value to the manufacturing process. Sjodin, et al. [27] cited Paper No. 174, which also discussed the servitization of manufacturing (#267). However, Paper No. 276 focused on the impact of servitization in manufacturing firms and attempted to suggest paths for firms to achieve a superior financial performance through servitization. Kohtamaki, et al. [28] cited Paper No. 174 and 267. The paper used an ecosystem perspective and proposes five digital servitization business models (#291).

The middle part of Figure 4 can be basically divided into the following sections: Industry 4.0 technology trends and impacts, dynamic capabilities, strategy and staff, and the impact of digitalization. First, Papers No. 195, 212, and 271 examined technology trends, factors influencing the adoption of new technologies, and countermeasures. Dremel, et al. [29] simply expressed the behavior of digital transformation in building big data analysis capability (#195). The paper has argued that digital transformation poses a serious challenge for traditional manufacturing companies because it requires organizational change. Based on the case study of Audi, the paper offered three suggestions for those companies to successfully build big data analytics capabilities: aligning organizational structures, establishing a data sharing culture, and applying agile methods. Through a systematic review, Ghobakhloo [30] presented the technological trends of Industry 4.0 and the general key steps for firms, providing a strategic guide for manufacturing companies to shift to Industry 4.0 (#212). Horvath and Szabo [31] further sorted out the enablers and hindrances of Industry 4.0, including the influence of the top manager on the Industry 4.0 process (#271). The study has suggested that increased competitive pressures, scarcity of labor resources, and executives' expectations drive the adoption of new technologies. In contrast, the lack of relevant human resources, insufficient assets, and resistance from employees and middle management will seriously hinder the process. Also, the study has shown that MNCs have far fewer barriers of employee boycotts than SMEs.

Second, the centerpiece of Papers No. 168 and 257 is the examination of dynamic capabilities against the background of enterprise digital transformation. Karimi and Walter [32] continued the study of dynamic capabilities under the theory of disruptive technological innovation (#168), which was studied in Paper No. 150. The paper was based on the theory of disruptive innovation and examines the effect of first-order dynamic capabilities (extending, modifying, changing, or creating ordinary capabilities) in coping with digital disruption. Their results have shown a positive correlation between first-order dynamic capabilities and the ability to build digital platforms, and it affects the performance of coping with digital interruption. In this case, the paper has also argued that the mindset of executives has a major role in developing the ability to innovate by adapting to the status quo. And in the newspaper industry, the authors referred to this mindset as multimedia thinking, which can be seen as the development of the digital thinking of Kodak executives mentioned in Paper No. 150. Warner and Wager [18] cited several of the above papers to continue the research on dynamic capabilities against the background of enterprise digital transformation (#257). Published only three years ago, this article has become the most cited article among all search results, which shows its significant impact on the study of corporate digital transformation. What is most notable about the paper is the decomposition of dynamic capabilities in digital transformation into three dimensions: digital sensing capabilities, digital seizing capabilities, and digital transforming capabilities. The authors further break it down into second-order dimensions and elaborate on the corresponding digital transformation behaviors. Many studies are currently conducting their own research based on this division.

Third, Papers No. 171, 182, 194, and 201 are on the topic of strategy. Issues such as digital strategy, the convergence of IT strategy and business strategy, and the CDO (Chief Digital Officer) and CIO are discussed. Hansen and Sia [33] provided an exploratory case study of how Hummel overcame challenges and successfully transitioned to omnichannel retailing (#171). The study showed that successful digital transformation for omnichannel retailing requires a convergence of business and IT strategies. In detail, trusting partners,

making profound changes, and utilizing the role of the CDO and CIO are critical to this success. Hess, et al. [34] used a digital transformation framework to compensate for the limitations of Paper No. 171, which did not propose a comprehensive approach for developing a company-wide digital transformation strategy (#182). The paper took a case study method and provided strategic guidance for companies' digital transformation by constructing an optional list. In it, digital transformation is classified into four areas: the utilization of technology, the change in value creation, the transformation of the structure, and finance, each of which represents the issues faced by companies undertaking digital transformation. The authors listed the strategic issues that may be encountered in each dimension and give strategic options to choose from. Notably, the article has also argued that IT strategy and digital transformation strategy are different, with the former not evolving into the latter. Therefore, in cases where digital transformation is centered on business processes, the CIO can manage the transformation. But if the focus is on connecting with customers, the company should have a dedicated CDO to work with the CIO. Singh and Hess [35] continued the discussion on CDOs from Paper No. 182. It described the management tasks and roles of the CDO through case studies of different industries (#194). The study has suggested that CDOs are primarily concerned with strategy and communications for digital transformation. If both CDO and CIO positions exist in a company, they should work closely together. The topic of the study conducted by Sebastian, et al. [36] was digital strategy, and it proposed two kinds: customer engagement and digital solutions, which must be supported by operational excellence and digital service platforms if the company wants to execute them (#201).

And finally, Papers No. 204 and 266 focused on analyzing the impact of digitization. Pagani and Pardo [37] examined the effect of digitization on B2B exchanges and explored the effect of adopting digital technologies on business network relationships (#204). And Ferreira JJM [38] discussed the effect of companies' adoption of new digital processes on their innovation and performance (#266).

The study of digital innovation is continued in Paper No. 193 in the right part of Figure 4. Huang et al. [39] conducted an in-depth process research in a digital enterprise. On the one hand, the article examined how the firm creates or initiates digital innovation using digital technology as a prime mover. On the other hand, the article also examined how the firm engages in digital innovation to initiate and sustain rapid expansion (business and user base). The study has found that digital businesses innovate through three mechanisms (data-driven operations, instant publishing, and rapid transformation) to rapidly expand their user base.

4.1.3. Diversified Development Stage (2020–Present)

In this phase, there is more highly cited literature, and the research on enterprise digital transformation shows a diversified development. Papers No. 358, 359, 360, and 361 are based on historical literature and explore the influence of IoT technologies on service-oriented business models, internal (dynamic capability perspective) and external (power change perspective) drivers of digital servitization, strategic organizational transformations that support digital servitization, and the relationship between suppliers and customers in digital servitization [40–43]. Verhoef, et al. [6] cited several historical papers for a systematic overview of digital transformation (#420). The study summarized the three phases of digital transformation: digital, digitization, and digital transformation, and describes the strategic preparations required to realize a successful digital transformation. The study conducted by Matarazzo, et al. [3] built on Papers No. 257 and 420, which for the first time link the adoption of digital technologies, dynamic capabilities, and value creation processes (#445). The study surveyed how the digital transformation of enterprises affects customer value creation and how dynamic capabilities contribute to digital transformation, against the background of Italian manufacturing SMEs. According to the results, digital tools enable business model innovation. Digital transformation can help companies to create new distribution channels and new processes, which creates value for customers. Bouncken,

et al. [44] discussed the content of BMI and proposed ways to digitize the business model of companies in terms of two dimensions: the focus of companies on one or more business models, and the degree of digitization of companies (#430). Urbinati, et al. [45] further investigated open innovation against the background of the digital transformation of companies, proposing an open innovation framework (#307).

The research focus of different stages of firm digital transformation research in the past 40 years can be collated, as shown in Table 5.

Table 5. Enterprise digital transformation research stages and themes (1985–2022).

Stage	Theme	Theories	Methods	Literature and Number
Budding Stage (1985–2014)	Influencing factors of enterprise digital transformation	Disruptive Technology Theory, Resource Matching, Strategic Matching	Case Study, Interview	Lucas and Goh [19] (#150); Liu, et al. [20] (#152); Kohli and Johnson [21] (#154); Hansen, et al. [22] (#155)
	Digital innovation	Digital Innovation Theory	Empirical Study	Fichman, et al. [23] (#166)
System Formation Stage (2015–2019)	Digitization and servitization	Dynamic Resource-Based View, Industrial Organization Theory, Resource-Based View, Organizational Identity Theory, Transaction Cost Theory	Case Study, Multi-case Study	Lerch and Gotsch [24] (#174); Coreynen, et al. [25] (#191)
	The antecedents of enterprise digital transformation	Digital Business Strategy Theory	Case Study, Interviews, Grounded Theory, Literature Review, Natural Language Processing Techniques	Dremel, et al. [29] (#195); Ghobakhloo [30] (#212); Horvath and Szabo [31] (#271)
	The process of enterprise digital transformation	Disruptive Innovation Theory, Dynamic Capability Theory, Destructive Technology Theory	Empirical Study, Qualitative Research, Case Study	Karimi and Walter [32] (#168); Sebastian, et al. [36] (#201); Warner and Wager [18] (#257); Hansen and Sia [33] (#171); Hess, et al. [34] (#182); Singh and Hess [35] (#194)
	Results of enterprise digital transformation	Innovation Management Theory, Knowledge Spillover Theory	Case Study, In-Depth Interview, Dual Metalogic Regression Analysis	Pagani and Pardo [37] (#204); Ferreira JJM [38] (#266)
	Digital innovation	Innovation Theory, Structuralist Theory, Network Economics Theory	Case Study	Huang et al. [39] (#193)
Diversified development stage (2020–2022)	Digitization and servitization	Dynamic Capability Theory, Contingency Theory, Innovation Theory	Quantitative Study, Multi-case Study	Coreynen, et al. [40] (#358); Kamalaldin, et al. [41] (#359); Paiola and Gebauer [42] (#360); Tronvoll, et al. [43] (#361)
	Motivation, development stage, and foundation of digital transformation	Multidisciplinary Perspectives Theory	Literature Review	Verhoef, et al. [6] (#420)
	Dynamic capabilities and value creation	Dynamic Capability Theory	Multi-case study	Matarazzo, et al. [3] (#445)
	Digital business model	Multidisciplinary Perspectives theory	Literature Review	Bouncken, et al. [44] (#430)
	Open innovation	Change Management Theory	Multi-case Study	Urbinati, et al. [45] (#307)

4.2. Keyword Co-Occurrence and Emergent Analysis Using CiteSpace

In general, articles published earlier have more citations, which results in HistCite citation mapping not accurately showing the latest research trends. Therefore, this paper

used CiteSpace for further analysis. We drew keyword co-occurrence mapping (Figure 5) and emergent keyword mapping (Figure 6) of the sample literature using CiteSpace. More specifically, in the CiteSpace panel, the node type was selected as "Keyword". After running the analysis, we clicked "Visualize" to form a keyword co-occurrence map. Then, we clicked "Burstness" in the control panel to detect the emergent words, and clicked "Refresh" to obtain the keyword emergent map. Among them, the keyword co-occurrence analysis is mainly used to generate the co-citation matrix by statistically analyzing the frequency of high-frequency keywords appearing in the same article. The co-citation analysis can show the hotspots in the field. The emergent keywords are the keywords with a sudden increase in frequency in a certain time period, which can further reflect the future development trend of the research.
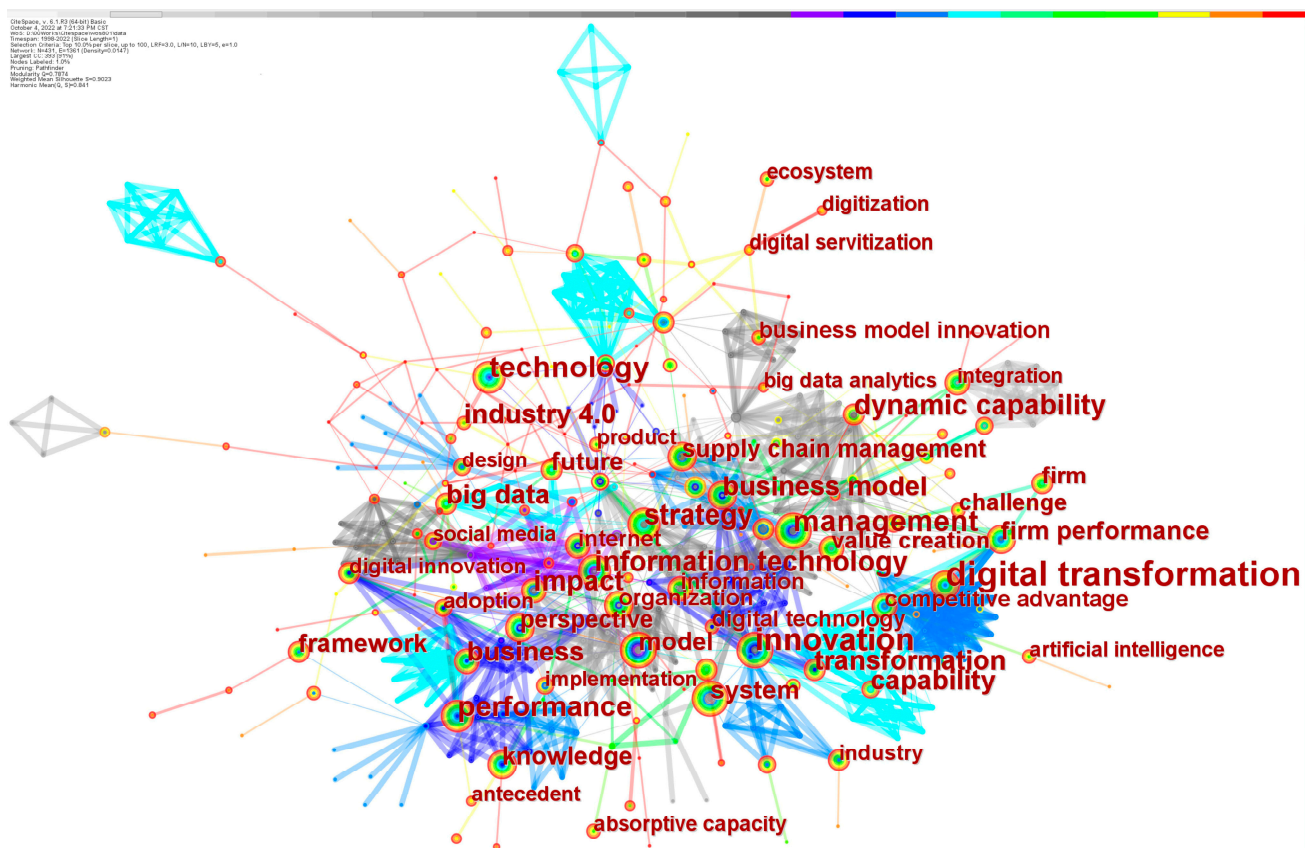

Figure 5. Enterprise digital transformation keyword co-occurrence mapping.

According to CiteSpace, the keywords with a frequency of more than 60 include digital transformation, innovation, technology, management, performance, dynamic capability, information technology, impact, strategy, transformation, big data, Industry 4.0, business, capability, business model, system, and enterprise performance. These 17 keywords constitute the main structure of the knowledge network in the area of firms' digital transformation research, and they represent the key study contents in this research field, which can be broadly summarized as "Industry 4.0 and digital transformation", "information technology, organizational change and performance", and "business model innovation". The keywords with a co-occurrence network centrality greater than 0.1 include: case study, innovation, duality, commitment, competitive advantage, convergence, information technology, evolution, digital platform, management, business model, digital product, big data analysis, value co-creation, corporate strategy, and proliferation. These 16 keywords basically cover the antecedents, processes, and results of digital transformation and are the issues that must be explored in this field. Among them, information technology, digital platform, digital product, and big data analysis belong to the antecedent elements of firms' digital trans-

formation. Innovation, management, business model, value co-creation, and enterprise strategy constitute the process factors. Competitive advantage represents the result factor.

Figure 6. Keyword emergence mapping of enterprise digital transformation. Note: The green line segment indicates the length of time the keyword appeared; the red line segment indicates the length of time from the burst to the end of the keyword.

Seen in Figure 6, the emerging keywords from 2017 to 2019 include business model, strategic management, integration, Industry 4.0, technological change, Internet, value chain, data analysis, and absorption capacity, etc. This phase primarily centers on how information technology affects organizational strategy, business models, and value creation in the context of the fourth industrial revolution. The degree of technological change in enterprises is influenced by its ability to absorb, transform, and utilize technology. The emergent keywords from 2020 to 2022 are knowledge management, which reflects the emphasis on knowledge management within the area of corporate digital transformation research in recent years, including knowledge protection, knowledge sharing, and other aspects. On the one hand, this reflects the impact of knowledge management on the digital transformation of firms. For firms that seek to achieve digital business transformation, exploring intangible resources through knowledge transfer and creation has become an essential strategy [46]. Enterprises need to promote the simultaneous construction of enterprise digital foundation and management capabilities through knowledge transactions [47]. On the other hand, this reflects the effect of companies' digital transformation on knowledge management. By using digital tools and technologies, organizations can store, manage, and share knowledge more efficiently than ever before [48,49]. This will lead to improved collaboration and communication, as well as faster and more accurate decision-making. In addition, the use of data analysis and artificial intelligence enables organizations to extract insights from a large amount of information, enabling them to make informed decisions and achieve better business results [50].

5. Discussion

The focus in the literature on the elements related to enterprise digital transformation is important for research and practice in this field. As stated in the introduction, technology is the core and foundation for enterprise digital transformation [4,36,39]. In this process, the capability of the enterprise itself is a significant influencing factor in determining the outcome of enterprise digital transformation [3,18,32]. In addition to this, the existing

literature has shown a strong relationship between firms' innovation orientation [23,32,45] and environmental characteristics [22] with firms' digital transformation. In the following subsection, we will discuss the concepts of these four elements and their impacts on firms' digital transformation performance. Based on this, we will construct a conceptual framework that can provide guidance for enterprises to obtain better digital transformation outcomes and that can also inform future research on enterprise digital transformation.

5.1. Digital Technology as a Fundamental Resource

According to the literature, enterprise digital transformation is the process of organizational change in enterprises via the application of digital technologies and their combinations [4,21]. Digital technology refers to information, computing, communication, and connectivity technologies and their combinations [4]. Digital technology not only helps organizations to improve the efficiency of their internal processes [24], but it can also lead to new products and services [19]. Digital technology adoption means the behavior of enterprises to actively screen, apply, and innovate digital technologies or their combinations in order to achieve certain purposes, including reducing costs, increasing competitive advantages, and improving innovation performance. According to the study conducted by Blichfeldt and Faullant [51], two dimensions can be used to reflect the level of digital technology adoption by firms: width and depth. The width of digital technology adoption reflects the type of technology adopted by the enterprise's digital technology. The depth of digital technology adoption reflects the willingness, frequency, and duration of enterprises to use digital technology.

5.2. Mediating Effects of Digital Dynamic Capabilities

Digital technology adoption triggered by enterprise digital transformation behavior will inevitably require the support of certain resources and capabilities. As stated in the previous papers #150 and #152, if the enterprise only acts within the existing technology on the basis of product services and other innovations, it is easy to fall into the path of dependence on the predicament, which is not conducive to enterprise digital transformation and upgrading [19,20]. Existing research proposes digital dynamic capabilities [18]. Compared to traditional dynamic competence, this formulation emphasizes the application of digital techniques and tools. As mentioned in Section 4, digital dynamic capabilities can be categorized into three dimensions based on the research of Warner and Wager [18]. These capabilities can help enterprises to optimize the resource transformation mechanism, rapidly reconfigure digital resources, enhance the efficiency of enterprise digital transformation, and reduce the risks of digital transformation. This shows that digital dynamic capabilities have a mediating effect between digital technology adoption and digital transformation performance.

5.3. Moderating Effects of Digital Innovation Orientation

The outcome of the digital transformation of a company may also be affected by its digital innovation orientation. Digital innovation orientations represent different directions and goals of digital innovation. According to the study of Fichman, et al. [23] on digital innovation, we categorize digital innovation orientations into three orientations: process innovation, product innovation, and business model innovation. On the one hand, digital innovation orientations can guide firms to adopt suitable digital technologies in a more targeted way. For example, if a company wants to submit organizational performance, it may prefer to choose digital technologies which are able to reduce transaction costs or establish a new transaction mechanism [52]. Digital transformation is a comprehensive and profound change, and enterprises need to overcome many internal and external obstacles. Digital innovation orientation can help enterprises to recognize the importance and necessity of digital transformation, and thus be more determined and motivated to advance the process. Therefore, it can be argued that digital innovation orientation is a key moderating factor in the process of enterprise digital transformation.

5.4. Moderating Effects of Environmental Characteristics of Enterprises

Enterprises survive in the environment, so the characteristics of the environment they are in will affect their digital transformation behavior and results. Figure 5 already shows the existing literature's attention to environmental factors. According to Jaworski and Kohli [53], we categorize the characteristics of the environment faced by firms into market turbulence, competitive intensity, and technological turbulence. It has been shown that environmental turbulence can provide substantial opportunities for enterprises to improve their sustainable competitiveness [54]. The effect of digital technology adoption on digital transformation performance is likely to be greater when the market environment faced by an organization is more volatile, competitive, or technologically up-to-date. For example, in highly competitive markets, enterprises are more likely to embrace digital technologies to improve operational efficiency, reduce costs, or innovate their products in order to gain an edge over the competition. At the same time, in this highly volatile environment, organizations need faster access to and integration of data, digital knowledge, and skills, as well as a higher capacity for digital innovation and change to better response to changes within the external environment [55–57]. Therefore, we argue that enterprise environment characteristics will regulate the relation among digital technology adoption, digital dynamic capabilities, and digital transformation performance.

5.5. A Conceptual Framework for Enterprise Digital Transformation

Enterprise digital transformation performance is a definition based on results, which is a measure of the effectiveness of an enterprise's digital transformation. Based on the results of the above bibliometric analysis and discussion, we construct a conceptual framework of enterprise digital transformation in four aspects, including digital technology adoption, digital dynamic capabilities, digital innovation orientation, and digital transformation performance (Figure 7).
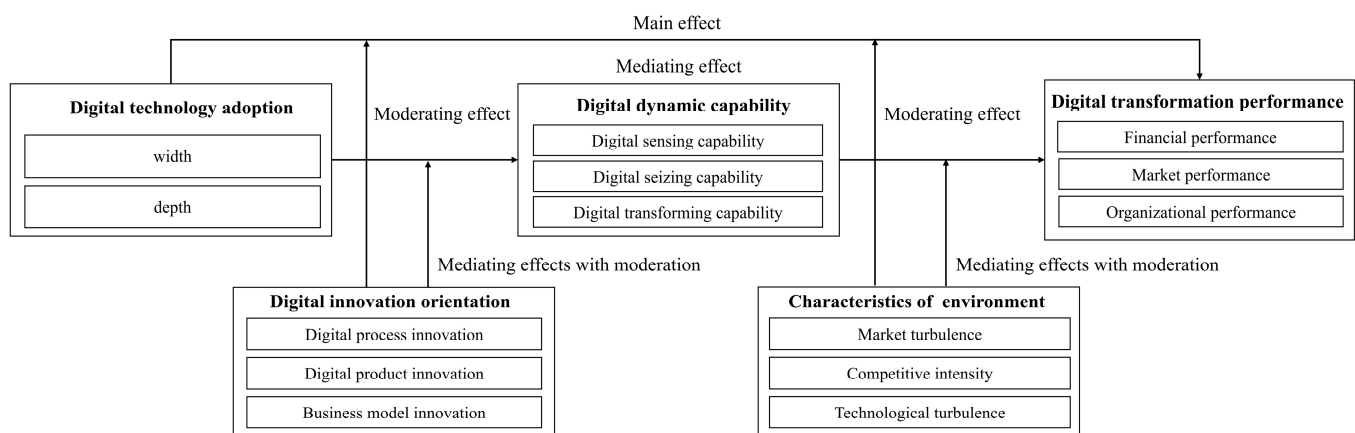

Figure 7. A conceptual framework for enterprise digital transformation.

Figure 7 provides a comprehensive perspective for future research on enterprise digital transformation. Combining the theories and research methods in Table 5, empirical studies or case studies can be conducted in the future to deeply explore the internal mechanisms and influencing factors of enterprise digital transformation. In terms of empirical research, researchers can collect data from target enterprises through questionnaire surveys or enterprise annual reports, then analyze and verify the actual effects of the four factors of digital technology, dynamic capabilities, innovation orientation, and the environment on digital transformation performance. Further, through the fuzzy set qualitative analysis approach, different grouping paths can also be proposed to improve the digital transformation performance. In addition, if different industries and sizes of enterprises are selected, more targeted and operable suggestions for enterprise digital transformation can be obtained.

Digital transformation practices in enterprises can also be informed by this framework. Companies must pay attention to the adoption of digital technologies [38]. Of course, both the extent and scope of adoption of these technologies need to be problem-specific. Second, dynamic capabilities are indispensable to the digital transformation of companies. The digital transformation behavior of companies triggered by digital technology adoption inevitably requires the support of certain resources and capabilities, and enterprises must re-examine whether existing resources and capabilities can cope with new demands and continuously tap into the value of data brought by digital technology with the help of dynamic capabilities to drive digital transformation [29]. Third, companies should care about digital innovation to create new use value for users or potential users, so as to achieve better transformation results [23,52]. Finally, to survive in a certain environment, companies must be aware of the impact of environmental factors such as market turmoil, fierce competition, and technological upheaval on digital transformation [22,55,56]. In conclusion, in an environment of rapid technological updates and iterations, unpredictable market demand, and highly competitive pressure, companies should mobilize their digital dynamic capabilities based on digital technology adoption, regulated by different digital innovation orientations, in order to improve digital transformation performance.

6. Conclusions

Digital transformation has become a topic that cannot be ignored in the field of economic management. This paper focused on a bibliometric analysis of digital transformation research at the firm level. It provided both an overview of enterprise digitization research and a reference for future research. The findings responded one by one to the research questions posed in Section 1. First, the descriptive statistical results of this paper are valuable for understanding a new research topic. We analyzed the evolution of enterprise digital transformation research in a quantitative mindset, reporting the key contributors, top journals and articles, and influential institutions and countries in the area of firms' digital transformation. Second, this paper reported on the stage research themes, related theories, and methodologies, which are informative for conducting theoretical studies. The results of the citation analysis reveal to us three developmental stages of research on the digital transformation of companies: the nascent stage, the system formation stage, and the diversified development stage. The reading and combing reveals that most of the studies are based on innovation theory, dynamic capability theory, or a resource-based view. Third, this paper also provided directions for further research. The results of the co-occurrence and emergence analysis reveal hotspots and trends. Based on the findings, it is clear that there is great scope for research on indicators for measuring digital innovation performance, as well as on knowledge management in the digital deluge. Finally, this paper proposed a conceptual framework that can help us to think about the performance of firms' digital transformation from a theoretical perspective. Corporate digital transformation is related to dynamic capabilities, digital innovation orientation, and environmental characteristics. Although most scholars have attempted to consider the impact of these factors on corporate digital transformation, the linkages between these four remain under-explored. Our research will provide a powerful complement to this.

The contribution of this study is reflected in the following aspects. First, this study centered on the current status of digital transformation at the enterprise level, and the findings were more informative for the micro subjects of the market—enterprises. Second, this paper conducted an in-depth bibliometric analysis of the literature on enterprise digital transformation, including descriptive statistics, citation analysis, and co-occurrence analysis, which provided strong data support for understanding the field. It is worth noting that, relative to other studies, this study innovatively used the HistCite tool to obtain the key literature in the research field and the relationship between the literature, and then sorted out the developmental stages of firms' digital transformation research through the categorized reading of the literature and summarized the research themes in each stage, which will show the developmental dynamics of enterprise digital transformation research

more clearly. Third, this study analyzed all aspects of enterprise digital transformation more comprehensively, not only focusing on technology application, but also considering multiple factors such as dynamic capabilities, digital innovation, and environmental variables, which provided a more comprehensive perspective. Finally, this study expanded the boundaries of existing research. We proposed new conceptual frameworks and research directions based on the bibliometric results and literature reading and combing to guide future research to explore aspects of enterprise digital transformation in greater depth.

This article exhibits certain limitations. First, we used HistCite as one of the research tools, but this tool can only analyze data from Web of Science, so our data sources are limited. Data from more databases can be considered in the future. Second, although we tried to include relevant literature on corporate digital transformation research in the sample data as much as possible when searching, relevant literature from non-subject areas may have been ignored because we restricted the search to economic management areas. In addition, when combing through the stages of research development, HistCite only considered literature in the top 30 of the LCS in order to present a tighter citation relationship, thus leading to some limitations.

Future research can be conducted in three aspects. In terms of antecedents, we can focus on how various antecedent variables such as information technology, digital economy, and digital platforms mentioned in existing studies affect enterprise digital transformation and whether these effects have group effects, etc. We can also further study how enterprises use digital infrastructure for transformation against the background of Industry 4.0, etc. In terms of process, future research can center on the process mechanism of the digital transformation of firms, including the mindset of employees, the mechanism of the function of dynamic capabilities on digital transformation process, the BMI process, and the dominant logic in the transformation process. In terms of results, it can focus on the positive and negative impacts of enterprise digital transformation, which include the impact of business model innovation, product and service innovation, etc., on organizational performance, how digital transformation improves organizational performance and operational efficiency, how value co-creation is carried out to shape the competitive advantage of enterprises, and what impact digital transformation has on the external environment, etc. In addition, in terms of research methodology, the utilization of additional tools such as VosViewer, Biblioshiny, and other resources could be considered in future bibliometric studies to achieve a more comprehensive analysis and provide different perspectives.

In summary, this study emphasizes the significance of understanding the complexities and challenges of digital transformation in organizations. It provides a valuable resource for scholars and practitioners interested in this area, provides a comprehensive overview of current research, and identifies key areas for future research.

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