

Research on Environmental Performance of Enterprises from the Perspective of Digital Transformation: A Knowledge Mapping Analysis Based on CiteSpace

Zhang Quanzhi¹, Hemaloshinee Vasudevan² and Cheok Mui Yee³

Universiti Tun Abdul Razak

zhang.quanzhi@ur.unirazak.edu.my

Abstract

Against the backdrop of the "Dual Carbon" strategic goals and the rapid advancement of the digital economy, digital transformation has gradually evolved into a critical pathway for enterprises to achieve green development and improve environmental performance. Adopting CiteSpace, a bibliometric analytical tool, this paper takes Chinese and English literature published from 2000 to 2025 themed on "digital transformation" and "corporate environmental performance" retrieved from China National Knowledge Infrastructure (CNKI) and the Web of Science Core Collection (WoS) as data sources. Through co-occurrence analysis, cluster analysis, burst term analysis and other methodologies, this study constructs knowledge maps of the research domain, and systematically sorts out its research hotspots, evolutionary trajectories and future research frontiers. The results indicate that: 1. High-frequency keywords in this field include green innovation, financing constraints and environmental regulation; 2. The research themes demonstrate an evolutionary tendency shifting from conceptual exploration to mechanism verification, and from single-dimensional perspectives to multi-dimensional interdisciplinary integration; 3. Emerging research frontiers such as green finance, supply chain digitalization and AI empowerment are emerging as new growth points. Ultimately, this paper proposes that future research can strengthen theoretical integration, deepen empirical tests and develop localized research frameworks, so as to provide theoretical underpinnings and practical references for corporate green transition and environmental governance amid digital transformation.

Keywords: digital transformation, corporate environmental performance, green innovation, knowledge graph, CiteSpace, bibliometric analysis

1. Introduction

Driven jointly by global climate change and sustainable development strategies, corporate environmental performance has emerged as one of the core indicators for evaluating enterprises' green transition and high-quality development. Particularly against the backdrop of China's "Dual Carbon" goals, how firms can elevate their environmental performance via technological revolution and managerial innovation has

attracted extensive attention from both academia and industrial practitioners. Meanwhile, digital transformation, as a vital approach to reconstruct corporate organizational structures, business processes and industrial ecosystems, is recognized as an essential pathway to advance green development and modernize environmental governance.

In recent years, scholars have carried out multi-dimensional investigations into how digital transformation shapes corporate environmental performance, with existing literature primarily falling into three strands. First, analyses from the mechanism perspective demonstrate that digital transformation improves corporate environmental performance by optimizing resource allocation, enhancing information transparency and stimulating green technological innovation. Second, regarding mediating channels, variables including financing constraints, environmental information disclosure and green innovation capacity are widely adopted to unpack the internal logical link between the two constructs. Third, research samples have expanded from the manufacturing sector to heavily polluting industries such as energy, coal and chemical industries; additionally, heterogeneous analyses covering eastern coastal, central and western regions have been conducted from a geographical perspective.

Nevertheless, despite the growing body of literature in this domain, three prominent limitations remain. To begin with, existing studies lack systematic integration, resulting in fragmented research agendas and insufficient theoretical accumulation. Second, a clear knowledge mapping framework is absent, which impedes the identification of correlations and influence hierarchies among pivotal publications. Third, most judgments on research hotspots and future frontiers rely on subjective experience rather than systematic and objective quantitative analytical tools.

Against such backdrop, this paper adopts bibliometric and visual analysis via CiteSpace to construct knowledge maps based on Chinese and English publications concerning digital transformation and corporate environmental performance published between 2000 and 2025. By conducting keyword co-occurrence analysis, document clustering, burst term detection and evolutionary trajectory analysis, this study systematically sorts out the developmental context, research hotspots and cutting-edge trends of this research field.

The innovations of this research are reflected in three dimensions. First, a multi-database integration strategy is adopted, covering core literatures retrieved from CNKI and the Web of Science Core Collection to improve the breadth and depth of analysis. Second, this paper focuses on the interdisciplinary theme of “digital transformation – environmental performance”, filling the research gap of visual bibliometric reviews in this specific field. Third, targeted suggestions for future research directions are put forward to provide forward-looking references for academic exploration and policy formulation.

In summary, digital transformation is not merely an outcome of the information technology revolution, but also a critical instrument for advancing green development strategies. Systematic review of this research field through scientometric tools such as

CiteSpace helps clarify theoretical foundations and knowledge architectures accumulated by prior studies, and facilitates the diversification, mechanism-oriented exploration and strategic advancement of research on corporate environmental performance.

2.Data Sources and Research Methodology

Bibliometric analysis constitutes a systematic approach to mining scientific knowledge, which can effectively reveal the developmental context, core themes, research frontiers and evolutionary trajectories of a specific research field. It has become one of the indispensable analytical tools for conducting literature reviews and identifying research hotspots at present. CiteSpace is a visual analysis software developed by Professor Chaomei Chen at Drexel University in the United States. Equipped with multiple analytical functions including co-occurrence analysis, cluster analysis and burst term detection, this software has been widely adopted to construct scientific knowledge maps and track the evolutionary trends of academic research[10]. Using CiteSpace (Version 6.2.R4), this paper conducts a visual analysis of Chinese and English literatures at the intersection of digital transformation and corporate environmental performance, aiming to systematically illustrate the intellectual base, developmental paths and research frontiers of this research domain.

2.1 Data Sources

This study aims to construct a bibliometric knowledge map for research on digital transformation and corporate environmental performance. Via visual analysis, it identifies high-frequency research themes, core publications, research network structures and evolutionary trajectories of frontiers in this field, so as to provide references for subsequent academic exploration.

To achieve the above objectives, this study adopts a dual-database retrieval strategy to collect literature from China National Knowledge Infrastructure (CNKI) and the Web of Science Core Collection (WoS Core Collection). The detailed data acquisition procedures are presented as follows:

1.Chinese literature retrieval In the CNKI database, the retrieval formula is set as Topic=(digital transformation + environmental performance), with the publication year limited to 2000–2025 and document type restricted to journal articles. A total of 236 Chinese records are initially retrieved. After manual screening and duplicate removal, 221 valid Chinese papers are finally retained.

2.English literature retrieval In the WoS Core Collection, the search string is defined as TS=("Digital Transformation" AND "Environmental Performance"). The time span is also confined to 2000–2025, and eligible document types include Articles and Reviews. The preliminary search yields 389 English publications. After eliminating irrelevant and

duplicate records, 333 English papers are incorporated into the final dataset.

3.Data preprocessing Records exported from CNKI are converted into a compatible format via NoteExpress before being imported into CiteSpace; raw WoS bibliographic data can be directly loaded into CiteSpace for processing. After data cleaning and filtering, a total of 554 core papers are obtained, consisting of 221 Chinese articles and 333 English articles. This dataset lays the foundation for subsequent keyword co-occurrence analysis, document clustering and burst term analysis.

2.2 Research Methodology

CiteSpace is selected as the analytical tool in this study owing to its robust functions in co-citation analysis, burst detection, cluster labeling, and timeline visualization. The overall analytical workflow consists of four steps as follows:

Step 1: Time Slicing and Data Preprocessing

The time span is set from 2015 to 2025, with each year defined as one time slice. The selected node types for analysis include Author, Institution, Country, Keyword, and Cited Reference. For each time slice, the top 50 items ranked by citation frequency or co-occurrence frequency are extracted to guarantee focused analysis and legible knowledge maps.

Step 2: Network Construction and Visualization

Keyword co-occurrence analysis is implemented to identify core research themes and hot topics within the field. Reference and author co-citation analyses are adopted to screen pivotal publications and unpack the intellectual base. The Log-Likelihood Ratio (LLR) algorithm is applied for cluster analysis, where the system automatically generates cluster labels followed by manual interpretation of thematic connotations. Burst detection is activated to capture keywords and publications with sharply rising citation volumes in recent years, which reflects the dynamic evolution of research frontiers.

Step 3: Parameter Configuration

The Pathfinder algorithm and the pruning sliced networks approach are adopted to simplify network architecture and highlight core structural patterns. Modularity Q and silhouette coefficient are utilized as evaluation indicators to assess the quality and internal consistency of clustering results.

Step 4: Cluster Interpretation and Result Validation

Each cluster is comprehensively assessed and interpreted based on cluster size, average publication year, and representative cited literatures. Cross-validation of the identified authors and institutions is conducted by comparing author metadata with the structure of the co-citation network. The technical methodologies adopted for bibliometric mapping are summarized in Table 1.

Table1 Input and Analytical Configurations of CiteSpace

Configuration Item	Setting
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Configuration Item	Setting
Analytical Software	CiteSpace (Version 6.2.R4)
Data Source	Web of Science Core Collection (journals indexed in SCI/SSCI)
File Format	Plain text (.txt), containing full records and cited references
Time Span	2015–2025
Time Slice Length	1 year per slice
Selected Node Types	Keywords, Authors, Institutions, Countries, Cited References
Analytical Types	Keyword co-occurrence, co-citation (authors/references), cluster detection, citation burst analysis
Selection Criteria	Top 50 items of each node type extracted per time slice
Counting Method	Full counting
Pruning Strategy	Pathfinder + Pruning sliced networks
Clustering Algorithm	Log-Likelihood Ratio (LLR)
Visualization Evaluation Metrics	Modularity Q, Silhouette Score, Burst Strength
Minimum Occurrence Threshold for Keywords	5
Burst Detection	Applied to cited references and keywords (Top N = 30)
Manual Data Cleansing	Author/institution disambiguation based on metadata
Auxiliary Tool	Microsoft Excel (PivotTable, word frequency retrieval)

2.3 Limitations and Rationality Explanation

Although CiteSpace performs well in capturing knowledge evolution and structural patterns, it has certain limitations in author name disambiguation and institutional aggregation. To address this issue, this study conducts corrections through manual data cleansing and cross-comparison with author and institutional metadata from the Web of Science. Compared with VOSviewer, CiteSpace boasts greater strengths in temporal evolution analysis and burst detection. It is particularly suitable for identifying research frontiers in dynamically developing and interdisciplinary fields such as green management of small and medium-sized enterprises (SMEs).

3 Analysis of Research Publication Outputs

3.1 Analysis of Annual Publication Volume

Publication volume serves as a vital indicator reflecting the research activity level and shifting research popularity within a specific academic field. Based on CiteSpace, this paper statistically counts Chinese and English papers collected from CNKI and the Web of Science Core Collection published between 2000 and 2025, and plots the trend chart of annual publication volume, as presented in Figure 1.

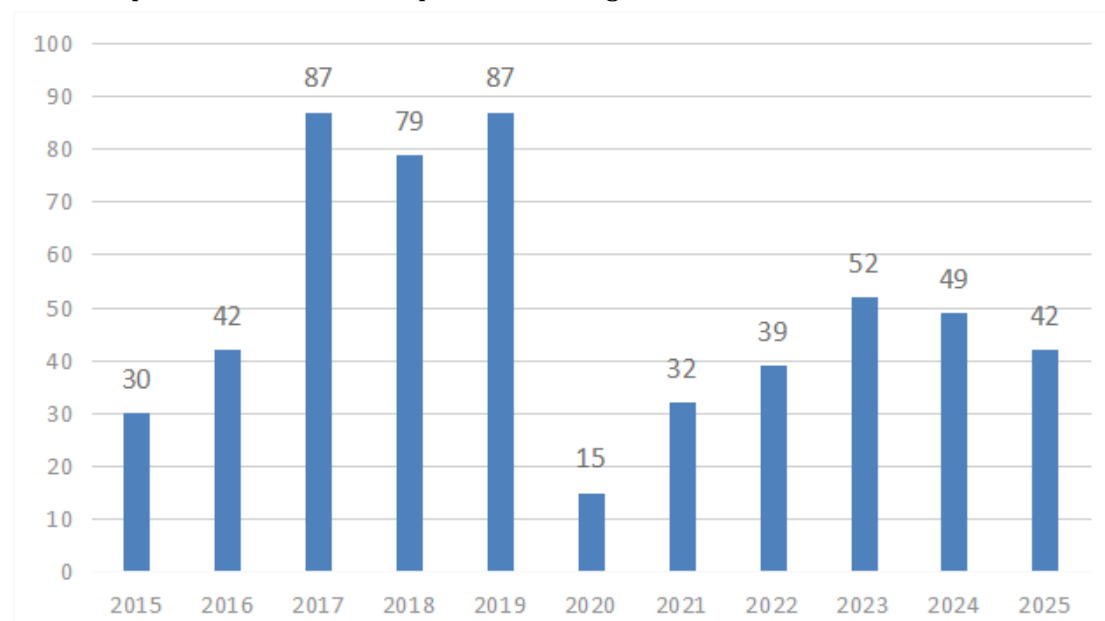


Figure 1 Trend of Annual Publication Outputs (2015–2025)

Figure 1 illustrates the changing trend of annual publication outputs on digital transformation and corporate environmental performance from 2015 to 2025. Overall, research in this field follows a three-stage trajectory: rapid growth, fluctuating adjustment, and renewed expansion.

First, the number of publications surged from 2015 to 2019, with 87 papers issued in both 2017 and 2019. This indicates that scholars paid intense attention to the integration of digital transformation and green development during this period, accompanied by a growing body of theoretical discussions and preliminary empirical analyses. Although a slight drop occurred in 2018, the field was still in a phase of rapid expansion. Research themes gradually shifted from macro policies and strategic frameworks to empirical examinations of corporate management and environmental performance.

Second, a notable trough emerged in 2020, with merely 15 publications. This decline can be attributed to the global outbreak of COVID-19, the reallocation of research resources, and restrictions on academic activities, which temporarily dampened research momentum in this domain. Nevertheless, publication volume rebounded steadily starting in 2021, signalling renewed academic interest in digital-driven green transition.

Third, publication numbers maintained a relatively stable range between 2022 and 2025: 39 papers in 2022, a secondary peak of 52 papers in 2023, a mild decline to 49 papers in 2024, and 42 papers in 2025. The steady publishing trend in this phase suggests that research has evolved from preliminary exploratory inquiries to in-depth mechanism analysis and expansion into subfields. Academic work has become more concentrated on themes including green innovation, corporate heterogeneity and policy effects, accompanied by prominent interdisciplinary integration.

In summary, the period 2015–2019 witnessed rapid growth, 2020 represented a trough and adjustment phase, and 2021–2025 saw recovery and stable development. This evolutionary trajectory reveals the developmental path of the research topic: from initial exploratory research to systematic in-depth analysis. Jointly fueled by policy incentives and technological advances, sustained academic enthusiasm has been maintained. Looking ahead, as digital technologies are further integrated with the Dual Carbon strategic goals, relevant research is expected to expand to a broader range of industrial contexts and cross-regional comparative studies.

3.2 Analysis of Influential Authors

Statistics on authors' publication outputs in this research field reveal that scholars studying digital transformation and corporate environmental performance are widely dispersed. Only a small number of productive researchers exist, and a canonical core author group has not yet taken shape. Based on the data exported from CiteSpace, the top ten authors ranked by publication volume are listed in Table 2.

Table 2 Top 10 Authors by Publication Output in Research on Digital Transformation and Corporate Environmental Performance

Rank	Author	Publication (Freq)	Frequency	Sigma Value
1	Zhang Changjiang	5		1.05
2	Dong Xiujuan	3		1.08
3	Li Wenchao	3		1.07
4	Dong Sixu	3		1.27
5	Li Fang	3		1.09
6	Liu Guang	3		1.09
7	Chang Yuan	2		1.08
8	Wang Ting	2		1.01

Rank	Author	Publication (Freq)	Frequency	Sigma Value
9	Yu Nushou	2		1.24
10	Yao Cuihong	2		1.13

Among these scholars, Zhang Changjiang ranks first with five publications, making him one of the most representative productive authors in this field. His research mainly focuses on the interactive nexus between corporate digital strategy and environmental performance, highlighting the role of digital capabilities in advancing green transition and improving environmental governance efficiency. Zhang's serial research outputs not only expand the evaluation framework of environmental performance theoretically, but also introduce a dynamic perspective of digital transformation methodologically, laying a solid reference foundation for subsequent empirical studies. In comparison, scholars including Dong Xiujuan, Li Wenchao, Dong Sixu, Li Fang and Liu Guang have published around three papers each, yet their research themes are diversified. Their works include empirical examinations of firm-level green innovation and the effects of environmental regulation, as well as theoretical modeling that examines digital-enabled green development from policy and strategic dimensions. Collectively, these studies drive the shift of relevant research from macro perspectives to micro firm-level analyses.

In addition, scholars such as Chang Yuan, Wang Ting, Yu Nushou and Yao Cuihong have only two publications apiece, yet their research perspectives feature distinctive novelty. For instance, they mostly adopt small and medium-sized enterprises, manufacturing industries or local governance as research cases to explore the application of digital transformation in specific scenarios and its heterogeneous impacts on environmental performance. To a certain extent, these outputs broaden the scope of existing research and offer new insights into corporate heterogeneity and regional disparities.

Overall, the author collaboration network in this field remains loose. Most scholars conduct research independently or within small research teams, with limited cross-team and cross-regional cooperation. This phenomenon is closely associated with the emerging and interdisciplinary nature of the research topic. Studies on digital transformation and corporate environmental performance cover multiple disciplines including management, environmental science, information technology and economics. Researchers tend to carry out investigations based on their respective disciplinary backgrounds, resulting in fragmented collaborative ties. Nevertheless, with the further implementation of the Dual Carbon Strategy and the rapid expansion of the digital economy, the demand for interdisciplinary collaboration will keep rising. It is expected that academic cooperation among scholars will be strengthened in the future, productive authors will exert more prominent leading effects, and the research community will gradually evolve from decentralization to agglomeration, thereby advancing the systematic and international development of this research field.

3.3 Analysis of Influential Institutions

From an institutional perspective, major contributing institutions conducting research on digital transformation and corporate environmental performance are widely distributed, covering finance and economics universities, comprehensive universities and several science and engineering colleges. On the whole, the number of high-output institutions is limited while their geographical distribution is relatively balanced, reflecting the interdisciplinary and multi-regional characteristics of research in this domain.

Table3 Top 10 Productive Institutions in Research on Digital Transformation and Corporate Environmental Performance Standard Academic Terminology

Rank	Institution Name	Publication	
		Frequency (Freq)	Sigma Value
1	School of Economics, Nankai University	9	1.12
2	School of Accounting, Lanzhou University of Finance and Economics	7	1.07
3	Business School, Hunan University	6	1.05
4	Business School, Central South University	5	1.03
5	School of Economics and Management, Nanjing Tech University	5	1.10
6	School of Management, Inner Mongolia University of Science and Technology	5	1.01
7	Business School, Renmin University of China	4	1.09
8	Zhongnan University of Economics and Law	4	1.10
9	School of Economics and Management, Beijing Forestry University	4	1.03
10	School of Management, Taiyuan University of Technology	4	1.02

As illustrated in Table 3, the School of Economics of Nankai University ranks first with nine publications and a high Sigma value of 1.12, demonstrating its core standing and sustained academic influence in advancing interdisciplinary research linking digital transformation and environmental performance. It is followed by the School of Accounting, Lanzhou University of Finance and Economics (7 publications, Sigma = 1.07) and the Business School, Hunan University (6 publications, Sigma = 1.05), which

indicates that universities in central and western China also exhibit robust research activity and substantial contributions to this field.

The Business School of Central South University, the School of Economics and Management of Nanjing Tech University, and the School of Management of Inner Mongolia University of Science and Technology each produced five papers. Among them, the School of Economics and Management of Nanjing Tech University achieves a Sigma value of 1.10, implying that it maintains steady publication output alongside prominent academic influence. Other top-ten institutions, including the Business School of Renmin University of China (Sigma = 1.09), Zhongnan University of Economics and Law (Sigma = 1.10), the School of Economics and Management of Beijing Forestry University (Sigma = 1.03), and the School of Management of Taiyuan University of Technology (Sigma = 1.02), leverage the interdisciplinary strengths of management and environmental science. Their research primarily centers on corporate green innovation, policy effects, environmental governance performance and related topics, facilitating the diversified expansion of research content.

Overall, these productive institutions are geographically distributed across North, Central, East and Northwest China. This pattern reveals that academic attention to digital transformation and corporate environmental performance has achieved comprehensive regional coverage nationwide, rather than being confined to developed coastal regions. Nevertheless, no dominant central research hub has emerged among institutions, and the overall spatial pattern remains decentralized. With the thorough implementation of the Dual Carbon Strategy and strengthened cross-regional academic collaboration in the future, several research teams and core scientific networks with substantial international academic influence are expected to take shape under the leadership of these high-output institutions.

3.4 Keyword Co-occurrence Analysis

The keyword co-occurrence network generated by CiteSpace (see Figure 2) presents a radial structure centered on the node of "environmental performance". As the largest and most cohesive core node, environmental performance radiates outward to multiple intertwined bands of high-frequency themes. This structural feature suggests that the research community has established a stable intellectual core revolving around how to measure and improve corporate environmental performance, with derivative research branches extending across performance measurement, governance mechanisms, technological innovation and policy instruments.



Corporate Environmental Performance

Among all research branches, performance measurement and audit represents the earliest research trajectory. The mapping reveals strong co-occurrence links between terms such as indicator system, evaluation indicators and comprehensive audit and the central node, demonstrating that academia initially focused on constructing scientific measurement models and auditing methodologies. Studies within this strand are frequently associated with research subjects including manufacturing industry, chemical enterprises and listed companies, and commonly adopt analytical tools such as DEA/SBM, entropy weight method and TOPSIS to lay comparable foundational data for subsequent empirical analyses.

As research advanced, the research strand of governance mechanisms and external supervision gained growing prominence. A tightly interconnected sub-network consisting of corporate governance, information disclosure and media attention frequently co-occurs with state-owned enterprises and listed companies. This evidence illustrates that internal governance structures and external oversight jointly shape

corporate green decision-making and environmental performance improvement. Specifically, information disclosure and media supervision strengthen constraints on corporate environmental accountability via reputation effects and financing channels. Meanwhile, this sub-network maintains close ties with environmental regulation and environmental governance, revealing interactive linkages between institutional pressure and corporate governance optimization.

Furthermore, interconnected keywords including green innovation, technological innovation and corporate innovation reflect that enterprises boost operational efficiency and process management via digitalization and technological advancement, thereby elevating environmental performance. Relevant research has expanded from single-firm analysis to green transformation of supply chains and production modes, highlighting the role of digital tools in process optimization, waste reduction and pollution control. Meanwhile, green investment and environmental regulation are linked to green finance and financing constraints within the network, embodying the influences of policy and financial instruments on corporate environmental behaviors. This thematic strand has alternately become a mainstream research entry point across different periods, covering both regulatory stringency and law enforcement disparities, as well as how capital markets incentivize corporate innovation and emission reduction through green finance and green bonds. Notably, multiple industry and region-specific keywords (e.g., chemical industry, state-owned enterprises, PM2.5) appear in the network, suggesting that industrial and regional contexts alter the marginal effects of governance, innovation and financial mechanisms. This shift signals that research has evolved from universal general propositions to refined heterogeneous analysis.

In summary, the intellectual mapping centered on environmental performance presents a well-structured framework: Methodological foundation: performance measurement and audit; Institutional dimension: a closed supervision loop of governance and oversight; Capability dimension: performance improvement pathways driven by innovation and digitalization; Policy dimension: supporting effects transmitted through regulation and financial instruments. From a temporal perspective, the research landscape has undergone three evolutionary phases: the construction of measurement indicators, the evaluation of institutional effects, and the exploration of green finance and digital technology-driven pathways. Future research is expected to deepen along three directions: refined environmental performance measurement, decomposed empirical testing of digital capabilities, and joint effect analysis of multi-dimensional policy instruments.

4 Analysis of Research Hotspots and Developmental Paths

4.1 Analysis of Evolutionary Paths Based on Timezone View

To uncover the dynamic evolutionary characteristics of research on digital

transformation and corporate environmental performance, this paper adopts CiteSpace to generate a keyword timezone map (see Figure 3). Judging from the overall structure of the mapping, the research lineage follows an evolutionary trajectory originating from performance measurement, then gradually expanding to cover governance mechanisms, green innovation, and digital empowerment. This trajectory reflects the phased shifts and logical progression of academic hotspots across the discipline.

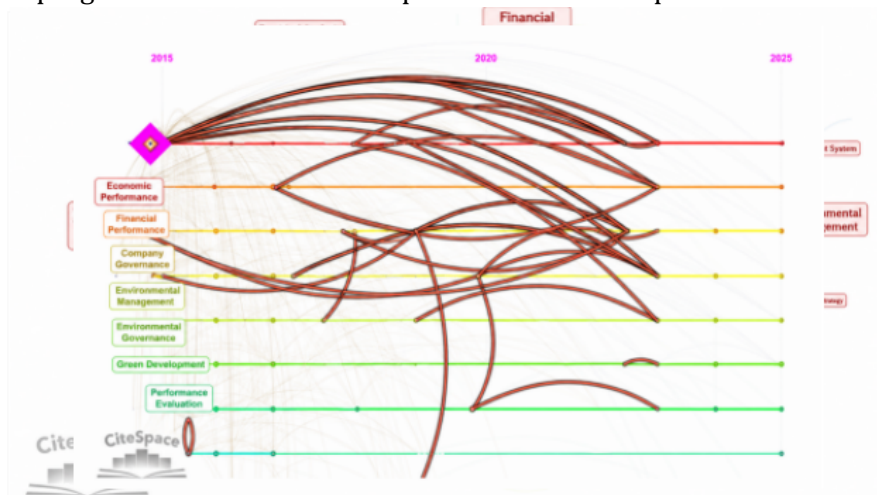


Figure 3 Keyword Timeline of Research on Digital Transformation and Corporate Environmental Performance

As illustrated in Figure 3, in the early stage (before 2015), the left side of the mapping centers on environmental performance, financial performance and economic performance, which feature large node sizes and dense links. This indicates that academic research at that time mainly revolved around performance measurement, with a primary focus on constructing evaluation indicator systems and auditing frameworks. Studies of this phase bore distinct methodological attributes, whose core objective was to develop quantitative tools for environmental performance assessment.

From 2015 to 2018, keywords including corporate governance, environmental regulation and environmental management emerged frequently in the mapping, forming multiple strong connections with the core performance nodes. This signals a gradual shift of research focus from pure measurement to institutional and governance effects, emphasizing how internal governance structures, external supervision and policy regulations shape corporate environmental performance, alongside the initial emergence of interdisciplinary research trends.

During 2019–2021, emerging nodes such as green innovation, green development and technological innovation appeared in the middle and lower-right sections of the graph, and coupled with established themes like corporate governance and environmental regulation. Research in this period highlighted the role of innovation-driven mechanisms in improving environmental performance, breaking through single-firm analytical perspectives to explore green synergy across industrial and supply chains, with more prominent networked and systematic characteristics.

In the latest phase (2022–2025), keywords including digital transformation, green

finance and intelligent manufacturing converge on the right side of the mapping and link to green innovation and performance evaluation, forming a three-dimensional interactive research framework of "technology-institution-finance". It demonstrates that research has evolved from performance measurement and institutional effect evaluation toward comprehensive governance empowered by digital technologies. Academic attention extends beyond internal corporate efficiency to policy coordination and analysis of regional heterogeneity.

In summary, Figure 3 intuitively depicts the evolutionary path of this field: indicator construction-institutional effect assessment-innovation-driven development-digital empowerment. It not only reflects the continuity of thematic expansion and methodological upgrading, but also identifies potential directions for future in-depth research-constructing a multi-dimensional collaborative mechanism for performance improvement under the backdrop of digitalization.

4.2 Emerging Research Frontiers Based on Burst Keywords

Burst keyword detection via CiteSpace identifies several cutting-edge research directions in recent literature on digital transformation and corporate environmental performance.

First, the burst of keywords including green finance, green bonds and digital finance reflects the critical role of financial support in corporate green transition. Research has expanded from institutional and governance effects to capital market perspectives, exploring the interactive relationships among green investment, financing constraints and environmental performance.

Second, rising digital technology terms such as intelligent manufacturing, big data and artificial intelligence reveal that scholars have begun to examine how digital tools boost corporate environmental performance through data collection, intelligent control and process optimization. This trend marks a deeper research phase focused on technology empowerment and innovation drivers.

Third, the burst of heterogeneity, supply chain and regional disparity indicates that research has moved from universal general conclusions to differentiated analysis, with greater attention paid to how corporate ownership types, industrial characteristics and regional policy backgrounds reshape pathways of performance improvement. Overall, burst keywords reveal a trinity frontier framework of "finance-technology-context". Future breakthroughs are expected in cross-disciplinary integration and context-specific practical applications.

5 Conclusions and Suggestions

5.1 Conclusions

A systematic review of literature on digital transformation and corporate environmental performance yields the following core conclusions: First, from the perspective of temporal evolution, research in this field has generally followed a four-stage trajectory: indicator construction, institutional effect evaluation, innovation-driven analysis and digital empowerment. Research themes keep expanding, research methodologies mature progressively, and interdisciplinary integration becomes increasingly prominent. Second, regarding research hotspots, early studies centered on performance measurement and auditing; mid-stage literature prioritized corporate governance, information disclosure and environmental regulation; recent research shifts to the combined effects of green innovation, digital tools and financial support, forming a new multi-dimensional coupling pattern of "technology-institution-finance".

Third, analysis of emerging frontiers shows that burst keywords such as green finance, intelligent manufacturing and digital finance signal a rapid research shift toward balanced development of technology empowerment and financial support, while corporate heterogeneity and regional differences have become new focal points.

In general, research in this domain has evolved from single-dimensional discussions to systematic, multi-dimensional and practice-oriented comprehensive analysis.

5.2 Suggestions

In light of the above conclusions, future research and practical work can be further advanced in the following aspects: First, researchers should continue to optimize the measurement methods of environmental performance, integrate big data and intelligent algorithms into the indicator system, and improve the scientificity and comparability of evaluation results. Second, scholars should further explore the functional mechanisms of digital capabilities across different enterprise categories and industries, and construct hierarchical frameworks covering data infrastructure, intelligent management and control, as well as supply chain collaboration, so as to provide multi-channel support for green innovation and emission reduction performance. Third, more research should be carried out on the synergistic effects of financial policies and environmental regulations, with a focus on examining how green financial instruments and regulatory stringency jointly shape corporate environmental behaviors. Fourth, cross-regional and interdisciplinary academic cooperation should be promoted to build high-level research teams and international scientific research networks, which can offer systematic theoretical support and practical pathways for the high-quality green development of enterprises under the Dual Carbon Strategy.

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