PAPER

Analysis of Synergistic Research on Digital Governance and Green Development under the Two-Carbon Target

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ABSTRACT

Green development and digital governance are closely related under the concept of "two carbons." In order to achieve the harmonious coexistence of humans and nature, the synergistic development of digital governance and green development is necessary to accomplish the goal of "two carbons." As the global economic structure undergoes a new round of industrial change and technological revolution, digital governance emerges as a dynamic force in the fields of science, technology, and economic development. It plays a crucial role in promoting green development in China. Therefore, this paper conducts further research on the synergistic development of digital governance and green development with the goal of achieving "two carbons." It systematically analyzes the relevant literature using the Cite Space big data literature analysis tool. The paper identifies and quantifies the research hotspots and keywords in the field of research through citation pattern and co-word analysis. Additionally, it reveals the knowledge evolution of the discipline by analyzing the time-series data of the citation relationship of the literature. We analyze the accumulation of literature results and changes in research trends to comprehend the developmental history and evolution of knowledge in the discipline. Additionally, we examine the research lineage and hotspots of scholars both domestically and internationally and explore the synergistic relationship between digital governance and green development in achieving the two-carbon goal.

KEYWORDS

digital governance, green development, synergy, two carbons, hotspots

1   INTRODUCTION

General Secretary Xi Jinping proposed at the 2020 United Nations General Assembly that China should strive to achieve a cap on carbon dioxide emissions by 2030 and carbon neutrality by 2060. This is referred to as the "two carbons" goal. Green development and digital governance are closely related within the framework of the "two carbons" concept. In order to achieve the harmonious coexistence of humans and nature, it is essential to promote the synergistic development of digital

governance and green development. Green development is crucial for achieving the "two carbons" goal, and the combination of the two will provide important impetus and support for economic development and social progress. The State Council issued the "Opinions on Accelerating New Urbanization (2021)" policy document, which focuses on promoting green urbanization and the construction of smart cities. The document proposes measures to enhance sustainable urban development, promote ecological environmental protection, encourage the economical use of resources, and strengthen the construction of smart cities. The Outline of the Development Strategy for the Construction of Digital China (2021–2025) emphasizes the significance of advancing digital governance and digital transformation. The Outline presents a series of goals and measures, which include promoting the development of digital infrastructure, fostering new dynamics in the digital economy, advancing the establishment of a digital government, and enhancing the capacity to train digital talents. The release of these policies aims to accelerate the advancement of green development and digital governance within the framework of carbon reduction.

With rapid economic development and industrialization, the issues of environmental pollution and resource consumption have become increasingly severe. Air pollution, water pollution, soil pollution, excessive energy consumption, and resource depletion have emerged as significant barriers to achieving sustainable development. China, being a major manufacturing nation, faces substantial energy demand. Historically, its industrial structure has been predominantly characterized by heavy industry and energy-intensive sectors, which hinders environmental conservation and the promotion of green development. In order to address these challenges, China has embarked on a proactive pursuit of a green development strategy. On January 19, 2023, the State Council published a white paper titled "China's Green Development in the New Era"[1]. This document provides a comprehensive overview of China's green development principles, initiatives, and accomplishments in the modern era while also sharing valuable insights into China's experience with green development. Let green become the most distinctive, dense, and vibrant background color of beautiful China, and let the people embrace the beauty of nature, life, and living amidst green waters and green mountains.

With the global economic structure being reshaped by a new round of industrial change and technological revolution, digital governance, as the most dynamic force in the fields of science, technology, and economic development, plays a crucial role in China's green development. On January 12, 2022, the State Council issued the "14th Five-Year Plan for the Development of the Digital Economy." The plan highlights that by 2025, significant progress will be made in the industrial structure and production mode of green low-carbon transformation. Green low-carbon technology and equipment will be extensively adopted, leading to a substantial improvement in energy and resource utilization efficiency. Furthermore, there will be a comprehensive upgrade in the level of green manufacturing. China's green development has entered the fast lane. The application of digital governance can enhance the efficiency and accuracy of environmental monitoring and management. It can also promote the effective utilization of resources and the adoption of environmental protection practices, thereby facilitating the achievement of sustainable development.

Digital governance under the "two carbons" goal provides a new research perspective and theoretical framework for sustainable development. By studying the concepts, principles, and practices of digital governance, we can enhance our comprehension of the application and influence of digital technology in the environmental sector. This, in turn, can foster innovation and advancement in green development theory. The study of digital governance and green development can

promote holistic thinking about the overall system. The application of digital technology usually involves multiple fields, stakeholders, and levels. To examine the correlation between digital governance and green development, it is essential to consider the interplay and harmonization among various domains, adopt a holistic approach, and foster the integrated and mutually beneficial aspects of green development.

Furthermore, examining the interdependent connection between digital governance and green development in pursuit of the "two carbons" objective can offer a scientific foundation and direction for policy formulation. Understanding the application value and potential of digital technology in green development can provide a reference for governments and organizations to formulate relevant policies and measures and promote the effective implementation of green development policies. Studying the relationship between digital governance and green development can provide guidance for implementing green development practices in different regions. Through an in-depth study of the application cases of digital technology in green city construction, energy management, and supply chain management, we can explore specific application paths and methods of digital technology in achieving the goal of green development. This will provide valuable reference and promotion experience for practical work. Therefore, this paper aims to conduct further research on the synergistic development of digital governance and green development under the goal of "two carbons." It systematically analyzes relevant literature using the Cite Space big data literature analysis tool. The paper identifies and quantifies research hotspots and keywords in the research field through citation pattern and co-word analysis. Additionally, it reveals the knowledge evolution of the discipline by analyzing the time-series data of the citation relationship of the literature [2]. The study observes the accumulation of literature results and changes in research trends to understand the development history and knowledge evolution of the discipline. It also analyzes the relevant research veins and research hotspots of scholars at home and abroad and explores the research veins and hotspots of the synergistic development relationship between digital governance and green development under the "two carbons" goal.

2 ANALYSIS OF THE RESEARCH LINEAGE AND HOTSPOTS OF SYNERGISTIC RESEARCH ON DIGITAL GOVERNANCE AND GREEN DEVELOPMENT UNDER THE TWO CARBON TARGET IN FOREIGN COUNTRIES

Research lineage refers to the developmental process and evolutionary trajectory of a subject area or research theme. It focuses on the historical background, current status, and future development direction of the discipline or theme. This includes the development history of the discipline, key milestones, and major research directions. Research lineage helps to understand the overall development of a discipline and the relationship between various fields within it. It allows us to grasp the progress and changes in the academic field from a macro perspective. A research hotspot refers to a research problem or theme that has garnered significant attention and discussion within the academic community during a specific time period. It can be an emerging research direction, a cutting-edge scientific issue, or a current research hotspot. Research hotspots are typically associated with the latest advancements in a discipline or a specific topic, and they garner significant influence and attention within the academic community. Research hotspots reflect the current focus of attention and research trends in academia [3].

2.1 Foreign digital governance related research lineage and hotspots

Keyword analysis. In this paper, we conducted a visual analysis of foreign research on digital governance, focusing on the keyword "digitalization" in the WOS core databases SCI and SSCI. The literature search was limited to articles published between 2008 and the present, resulting in a total of 4,762 articles. Analysis of the literature search reveals that the research focus on digitization is primarily centered around design, manufacturing, management, and other disciplines. In order to obtain digitization articles specifically related to the high-end manufacturing industry, this study further narrows down the selection criteria and focuses on the "management" category as the research field. As a result, a total of 412 articles were selected. After screening the data and excluding conference papers, newspaper articles, books, and other documents, we manually de-weighted the data and obtained a total of 383 valid sample documents.

Table 1. Conditions for checking data in the study sample

Search Condition Category	Search Condition Assumption
Retrieval date	August 15, 2023
Time threshold	2008–2023
Databases	WOS
Search strategy	Search Topics "Digitalization"
Node type	Keyboard

Keywords are crucial elements that can convey the central concept of an article and emphasize its theme. By studying keywords, one can gain a better understanding of the research focus of the article. The frequency of keywords is an important indicator of the popularity of a research field. Therefore, in this paper, the co-occurrences of keywords from 383 digitization-related articles was analyzed. The top 12 keywords were identified, and the resulting keyword map is shown in Figure 1. There are 347 nodes and 1,832 connecting lines in the graph. The size of the circle in the graph represents the frequency of co-occurrence of the keywords. Among them, digitalization has the highest number of occurrences with a total of 133 mentions, followed by innovation, management, technology, framework, and so on. The more frequently the keywords co-occur, the larger the node becomes. However, a larger node does not necessarily indicate a higher centrality. Centrality indicates the connection between a word and other keywords, which is represented by the number of lines connecting the nodes. The centrality of the keyword "digitalization" is greater than 0.1, indicating that it has more connections with other keywords and more influence on them. Additionally, the centrality of the keywords "innovation" and "management" is 0.06 and 0.08, respectively, indicating a significant influence. Therefore, in the field of foreign digitization, innovation and management should be the focus of managers. The relationship between digitalization, innovation, and management can be developed from the following two aspects.

On the one hand, digitization provides great opportunities and platforms for innovation. The rapid development and spread of digital technologies have made innovation easier and more efficient. For example, the rise of the Internet and mobile applications has created a platform for new business models and services, opening up numerous entrepreneurial opportunities. At the same time, digitization also provides access to a wealth of data and information resources, which serve as valuable references and support for innovation. Innovation can enhance products,

streamline processes, deliver personalized services, and more through the use of digital technology. At the same time, innovation plays a crucial role in the development of digitalization. The increasing demand for innovation drives the utilization and application of digital technologies. For example, the development of artificial intelligence is closely linked to the demand for smarter and more efficient solutions [4]. Innovation also brings new business needs that require digitization to support and enable them. For example, companies need digitalization to enable supply chain integration and management in order to adapt to the changes brought about by innovation.

On the other hand, management plays an important role in the digitization and innovation process [5]. Management needs to effectively plan and control the resources, processes, and risks associated with digitization and innovation. Digitalization and innovation usually require cross-departmental and cross-organizational collaboration. Effective organizational structures and processes provided by management can enable smooth running of digitalization and innovation. Management also needs to evaluate and monitor the digitization and innovation process to ensure that the desired results and goals are achieved. Digitization and innovation also pose new challenges to management. Digitization and innovation are often accompanied by uncertainty and change, necessitating flexible management approaches and organizational cultures that can adapt and lead change. Management needs to continuously learn and update its knowledge to keep pace with digitization and innovation. Management also needs to focus on important issues such as data security and privacy protection brought about by digitization, as well as risk management in the innovation process.

Fig. 1. Keyword mapping of foreign digital research

Table 2. Top ten keywords of foreign digitized postings

Rankings	Volume of Publications	Centrality	Particular Year	Keyword
1	133	0.12	2010	digitalization
2	70	0.06	2010	Innovation
3	55	0.08	2017	Management
4	52	0.04	2019	Impact
5	51	0.07	2010	Technology
6	43	0.06	2018	Performance
7	36	0.01	2020	Digital transformation
8	36	0.01	2020	Sustainability
9	35	0.06	2012	Framework
10	33	0.03	2018	Model

In summary, it is evident that there is a strong link between digitization, innovation, and management abroad. Digitization provides a platform and opportunity for innovation. Innovation, in turn, promotes the development of digitization. Additionally, effective management plays a crucial role in the process of digitization and innovation. They support and promote one another, and improve through the continuous process of digitization. This all provides new research ideas and a theoretical basis for subsequent research on digitalization.

Cluster analysis. In order to delve deeper into the research trends and knowledge structure of foreign digitization-related articles, this paper conducted a cluster analysis of the keywords using the log-likelihood method (LLR) algorithm. The analysis resulted in a time-series mapping of the keywords, as depicted in Figure 2. A total of 19 clusters were identified from the analysis of 383 articles. The number preceding each cluster indicates the amount of literature contained within it, with smaller numbers indicating a higher volume of literature. Among them, the closer the s value is to 1, the higher the homogeneity of the network. When the s value is 0.7, the clustering results have high confidence. A s value greater than 0.5 indicates that the clustering is reasonable, and the s value of 0.7494 indicates a fairly high level of confidence in the clustering. The interval of the q value is 0–1, and when the Q value is greater than 0.3, it indicates that the association structure of the clusters is significant. The Q value of 0.4703 indicates that the association structure of the clusters is significant [6].
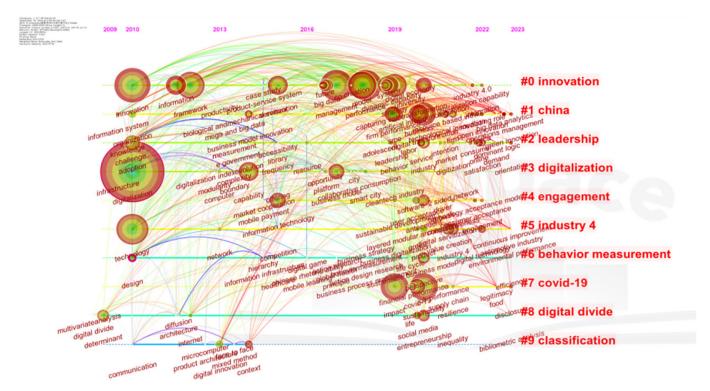

Fig. 2. Time series mapping of foreign digitized keyword clustering

This led to the formation of the following clusters: innovation, China, leadership, digitalization, engagement, industry 4.0, behavior measurement, COVID-19, digital divide, and classification. Ranked the top ten clusters. In these clusters, apart from the theme words and management terms, the remaining clusters are somehow related to digitization. Overall, there appear to be intricate interactions and connections between digitalization abroad and innovation, China, leadership, Industry 4.0,

behavioral measurement, COVID-19, and the digital divide. Together, these issues and challenges are crucial in the digital era and demand collaborative global efforts to promote digitalization and tackle associated problems.

Trend analysis of research hotspots. The prominence of keywords can indicate the research hotspots at different stages. Analyzing the prominence of keywords can assist in identifying the hotspots in this research field and predicting future development trends. Figure 3 lists the 14 keywords that are most prominent in foreign digitization at different time stages. These keywords can be roughly categorized into 4 stages based on the analysis.

Top 14 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2009 - 2023
communication	2009	2.53	2010	2014	
modularity	2009	1.88	2013	2017	
productivity	2009	1.63	2013	2019	
evolution	2009	1.91	2014	2015	
design	2009	1.95	2015	2019	
big data	2009	2.17	2017	2019	
platform	2009	1.69	2017	2018	
smart city	2009	2.44	2018	2020	
internet	2009	1.91	2019	2020	
future	2009	1.73	2019	2020	
firm performance	2009	1.55	2019	2020	
product	2009	2.45	2020	2021	
perspective	2009	1.59	2020	2021	
adoption	2009	1.42	2020	2021	

Fig. 3. Foreign digitized keyword prominence

Basic Concepts Category (Early Stage): Communication (2010–2014). During this period, the development of communication technology became the foundation for digitization. Advances in communication technology provide a faster and more convenient way to transfer and exchange information.

Technology and Methodology category (mid-term phase): modularity (2013–2017), productivity (2013–2019), design (2015–2019), and big data (2017–2019). The modular approach to design and development makes the system more flexible and extensible, which contributes to the rapid upgrading and integration of digital technologies [7]. The wide application of digitization has led to an increase in productivity. Through digital technology, companies are able to optimize production processes, improve efficiency, and achieve higher levels of productivity. At the same time, digital technology also brings new possibilities for design. Through the use of digital tools and platforms, designers can create and bring their ideas to life more efficiently, thereby fostering innovation and advancement in the design industry. The concept of big data emerged. The digital era has generated a large amount of data that can be collected, analyzed, and utilized to gain deeper insights and support decision-making.

Development Trends and Transformation Category (Mid to Late Stage): evolution (2014–2015), platform (2017–2018), smart city (2018–2020), and internet (2019–2020). The digitalization space is undergoing an unprecedented and rapid evolution in this phase. New technologies and concepts continue to emerge, driving digitization and innovation. The rise of digital platforms has driven the growth of digitization. Through digital platforms, companies can integrate diverse resources and services to achieve more efficient collaboration and value creation. The application of digital technology in urban management and public services makes cities smarter [8]. The introduction and promotion of the concept of smart cities have accelerated the process of urban digitization. In this era of digitalization, the Internet

plays an important role. The development of the Internet connects information and services, promoting the rapid popularization and application of digitalization.

Future Outlook and Impact Category (Late Stage): future (2019–2020), company performance (2019–2020), products (2020–2021), perspectives (2020–2021), and adoption (2020–2021). The future impact and prospects of digitization technologies are at the center of attention. Digitization is expected to continue evolving and transforming various fields in the future. The rapid development of digitization has triggered various perspectives and opinions. Digital technologies have made the design, manufacturing, and delivery of products smarter and more personalized. The push towards digitalization has led to a trend of digital and intelligent products in all sectors. Product diversification has also had a significant impact on the performance of companies. Through digital transformation, companies are able to improve operational efficiency and enhance the customer experience, leading to performance growth. Nowadays, with the rapid growth of digitization, scholars, experts, and the industry have presented various perspectives and predictions regarding the impact and future development of digitization. The adoption of digitization technologies is increasing at this stage.

Such a categorization has been plotted over time based on the nature of the different phases of concepts, technologies, trends, and impacts indicated by the keywords. This has aided in comprehending the evolution and development process of these keywords.

2.2 Research on green development and hot spots in foreign countries

Keyword analysis. In this paper, we conducted a visualization analysis of foreign research on green development. We searched the WOS core database using the keywords "Green development" and "Sustainable development", as well as SCI and SSCI related literature. A literature search was conducted on SCI and SSCI databases, with a limited search time from 2008 to the present. A total of 16,169 articles were searched and analyzed. The results indicate that the research theme of green development in foreign countries is primarily focused on sustainable science, management, forestry, and other disciplines. In order to obtain articles specifically related to green development in digitalization, further screening was conducted, with a focus on the "management" research field. This resulted in a total of 1,225 articles. After conducting data screening, conference proceedings, newspaper articles, books, and other documents were manually excluded. Subsequently, they were manually de-emphasized, resulting in a final selection of 861 valid sample documents.

Table 3. Conditions for checking data in the study sample

Type of Search Condition	Search Condition Hypothesis
Retrieval date	August 15, 2023
Time Threshold	2008–2023
Database	WOS
Retrieval strategy	Retrieval subject "Green development" "Sustainable development"
Node type	Keyboard

The valid sample literature keywords were analyzed to identify the top 12 co-occurring keywords. The generated keyword map is shown in Figure 4.

There are a total of 500 nodes and 3488 connecting lines, which indicated that research on foreign green development predates research on digitalization. Performance has the highest number of occurrences, followed by sustainable development, sustainability, management, and so on. The centrality of the keyword "sustainable development" is 0.15, which exceeds 0.1 and is considered a key node. Noteworthy keywords are and innovation, with centrality scores of 0.07 and 0.06 respectively. The analysis focuses on the relationship between green development and performance and innovation in foreign countries. This analysis to clarify the connection between related articles and provides a deeper understanding of green development.

The relationship between green development, innovation, and performance is mutually reinforcing. Innovation drives green development. Through innovation, new green technologies, solutions, and business models can be proposed to provide better solutions for environmental sustainability and resource efficiency. Innovation can transform current production and consumption patterns, fostering the advancement and utilization of clean energy, the adoption of a circular economy, and the promotion of environmentally friendly products and services [9].

On the contrary, the requirements of green development drive the creation and development of innovation. In order to meet the demands of environmental protection and sustainable development, businesses and organizations need to constantly seek innovative solutions. The goal of green development is to encourage scientific and technological innovation, product innovation, and management innovation in order to achieve greener and more sustainable development paths.

The generation and development of innovation can further improve performance, and innovation has a positive impact on the performance of green development. By introducing and implementing new green technologies and solutions, businesses can enhance resource efficiency, mitigate environmental pollution, and reduce costs. These initiatives can help improve business performance indicators such as energy efficiency, carbon emissions, waste management, and productivity. Innovation can also improve competitiveness and market position, bringing long-term business value to the organization [10].

In turn, improved environmental performance drives innovation, and monitoring and evaluating green performance can incentivize enterprises to innovate. Through evaluating and disclosing an enterprise's environmental performance, society and the market can gain a better understanding of the enterprise's environmental impact. This transparency encourages enterprises to take innovative measures to improve their environmental performance in response to stakeholder and market demands.
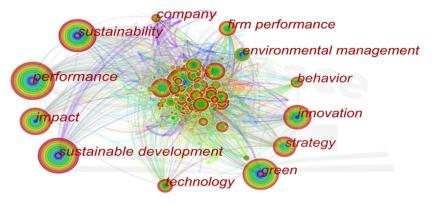

Fig. 4. Keyword mapping of green development research abroad

Table 4. Top ten keywords in the volume of articles on green development abroad

Rank	Publications	Centrality	Year	Keyword
1	225	0.07	2008	Performance
2	224	0.15	2008	Sustainable development
3	189	0.11	2008	Sustainability
4	170	0.05	2008	Management
5	163	0.06	2008	Impact
6	162	0.05	2008	Green
7	120	0.06	2008	Innovation
8	109	0.01	2017	Green innovation
9	100	0.05	2012	Strategy
10	97	0.03	2009	Model

Taken together, the above analysis shows that there is a virtuous circle between green development, innovation, and performance abroad through mutual reinforcement and feedback. Innovation drives green development and enhances the performance of enterprises and organizations in environmentally-friendly sectors. Assessing and monitoring green performance, in turn, drives innovation and the development of more environmentally friendly and sustainable solutions. Innovation in policies and regulations also provides the necessary support and guidance for sustainable development. Such interactions help to advance green transformation and sustainable development abroad [11].

Cluster analysis. Using the same analysis method as described above, a total of 861 documents related to green development in foreign countries were clustered and analyzed. The resulting clustered time series mapping is shown in Figure 5. In total, 16 clusters are visible in Figure 5, with an s value of 0.6885, which indicates that the clusters have a fairly high degree of confidence; the interval of q value is 0–1, and when the Q value is greater than 0.3, it indicates that the association structure of the clusters is significant, and the Q value is 0.3511, indicating that the clusters are indeed significant. Therefore, the graph holds a reference value.
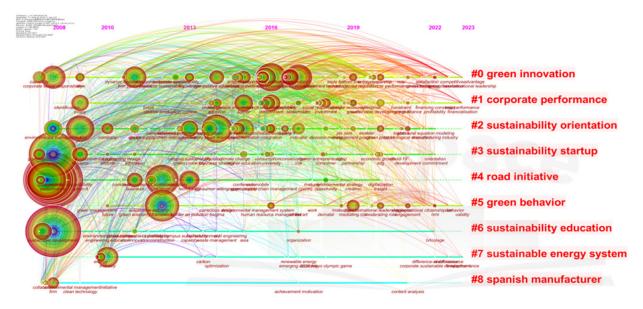

Fig. 5. Time series mapping of keyword clustering of green development in foreign countries

In each of these cluster maps, there is a close relationship with sustainable development abroad. These keywords all relate to various aspects of sustainable development overseas. Keywords such as green innovation, sustainability orientation, and sustainability startups emphasize the significance of innovation and business practices in promoting green development globally. Sustainable energy systems emphasize the development and application of renewable energy sources, while green infrastructure development is promoted by the Road Initiative. Education for Sustainable Development focuses on building educational systems that foster awareness and capacity for sustainable development. Spanish manufacturers play a crucial role in promoting green development internationally.

Together, these keywords form a comprehensive framework for green development that highlights the significance of various dimensions, including innovation, orientation, behavior, energy, education, and industry, in promoting sustainable development globally. They are interrelated and complementary, and together they drive the transformation towards a greener and more sustainable development abroad.

Trend analysis of research hotspots. The research focus of foreign scholars can be identified by analyzing keywords. Based on the analysis of keywords related to green development in foreign countries, as shown in Figure 6, the research on green development in foreign countries can be categorized into the following eight stages:

Keywords	Year	Strength	Begin	End	2008 - 2023
eco-innovation	2008	4.09	**2011**	2016	
design	2008	2.95	**2011**	2018	
environmental management	2008	7.12	**2012**	2018	
green	2008	5.62	**2012**	2014	
green supply chain management	2008	4.51	**2012**	2017	
environmental sustainability	2008	3.28	**2012**	2015	
supply chain management	2008	3.77	**2014**	2017	
supply chain	2008	2.92	**2014**	2016	
operation	2008	3.85	**2016**	2017	
selection	2008	3.21	**2016**	2018	
sustainable operation	2008	3.01	**2016**	2017	
integration	2008	3.55	**2018**	2020	
opportunity	2008	3.49	**2018**	2020	
sustainable development goal	2008	4.34	**2020**	2021	
transformational leadership	2008	3.16	**2020**	2021	

Fig. 6. Top 15 keywords with the strongest citation bursts

Eco-Innovation (2011–2016) and Design (2011–2016), Environmental Management (2012–2018) and Green (2012–2014), Green Supply Chain Management (2012–2017) and Environmental Sustainability (2012–2015), Operations (2016–2017) and Choices (2016–2018), Sustainable Operations (2016–2017) and Integration (2018–2020), Opportunities (2018–2020) and Sustainable Development Goals (2020–2021), and Transformational Leadership (2020–2021). These keywords collectively form a framework for understanding the progress and emphasis of green development overseas throughout the years. From a focus on innovation and design, environmental stewardship, and greening to environmental sustainability, supply chain management, operations, choice, integration, opportunity, and the SDGs, these keywords represent a gradual evolution of green development. They emphasize the significance of achieving sustainable development on a global scale.

2.3 Hot spot analysis of research on the combination of digitization and green development in foreign countries

After conducting visualization analysis, research hotspot trend analysis, and keyword highlighting on relevant literature by foreign scholars on digitalization and green development, the keywords of the top ten publications in these research fields were compared and analyzed. The results, as shown in Table 5, indicate that the keywords sustainability, management, impact, innovation, performance, and model appear frequently in the literature on digitization and green development. These six keywords can be categorized based on their roles and impacts on digitization and green development. The three keywords of sustainability, management, and impact emphasize the critical role and impacts of digitization technologies on sustainability at the macro level. On the other hand, the keywords Innovation, Performance, and Model highlight how digital technologies can contribute to green development at the micro level by promoting innovation, efficiency, and paradigm shift.

Table 5. Comparison of keywords in foreign literature related to digitalization and green development

Top 10 Keywords for Green Development Postings Abroad	Top 10 Keywords for Digitalization Postings Abroad
Performance	digitalization
Sustainable development	Innovation
Sustainability	Management
Management	Impact
Impact	Technology
Green	Performance
Innovation	Digital transformation
Green innovation	Sustainability
Strategy	Framework
Model	Model

After analyzing and summarizing the relevant literature on "digitalization" and "green development," this paper finds that some scholars have conducted in-depth studies on the key role and impact of digitalization on green development. Furthermore, they have explored the promotion of digitalization in the context of green development. Based on this analysis, this paper searched the SCI, SSCI, and SSCI articles in the WOS database using "green development" and "digitalization" as keywords. The search interval was set from 2008 to 2023. A total of 150 articles were retrieved. In order to enhance the credibility of the articles, this paper also searched the DDS foreign language doctoral and master's thesis databases using the same theme. However, no articles were found, indicating that the connection between digitalization and green development has not been explored in foreign-language doctoral theses. Although there are numerous foreign language studies on the relationship between digitalization and green development, there are still limited studies that combine the two. This suggests that there is still ample room for exploration in this field. This indicates that there is still much room for exploration in this field.

Although numerous studies have found a positive correlation between digitalization and green development, ZHONG and SH (2023) examined the impact of

digital financial development on the industrial green transformation using data from Chinese cities and listed companies. They deconstructed industrial green transformation into two aspects: industrial efficiency green transformation and industrial structure and green transformation. However, they found that digital finance has a significant facilitating effect on industrial structure and green transformation but has an inhibiting effect on industrial efficiency green transformation. This inspires us that when studying the relationship between digital transformation and green development, we should not only focus on the surface-level connection but also clarify the internal structure and relationship between them [12].

3 ANALYSIS OF RESEARCH HOTSPOTS FOR SYNERGY BETWEEN DIGITAL GOVERNANCE AND GREEN DEVELOPMENT UNDER THE TWO-CARBON GOAL

Through the analysis and summary of the previous article, it can be concluded that the hotspot analysis of the integration of digitalization and green development in the context of decarbonization primarily focuses on the following points:

1. Renewable energy and digitalization: Digital technologies, such as big data analysis, artificial intelligence, and the Internet of Things (IoT), are widely used in the field of renewable energy to improve the efficiency of energy production and utilization. For example, through smart grid monitoring, remote management of wind and solar power generation equipment, and energy-saving programs for smart homes.
2. Digital Smart Cities: Digital technologies offer numerous opportunities for cities to operate more intelligently and efficiently, while also reducing environmental pollution. This includes smart traffic management, smart waste disposal, and smart buildings, all aimed at improving the quality of urban life and reducing energy consumption.
3. Digital agriculture: The application of digital technologies in agriculture can help improve food production efficiency and the quality of crops. For example, by utilizing sensors and drone monitoring, farmers can obtain real-time information on soil moisture and crop growth. This enables them to optimize fertilizer application and irrigation, reducing the need for chemical fertilizers and water usage.
4. Circular economy and digitization: Digital technologies can be used to promote the development of a circular economy by tracking and managing the material cycle through the use of big data and blockchain technologies. This can help reduce resource waste and environmental pollution. Digital technology also helps to enhance the efficiency of waste management and recycling, thereby improving the rate of waste reuse.
5. Digital carbon emission reduction: Digital technologies can be used to monitor and assess carbon emissions, thereby assisting enterprises and governments in implementing measures to reduce emissions. And these technologies include smart grids, electric vehicles, smart sensors, and so on. In addition, digital technologies can also help improve energy efficiency, such as by reducing energy consumption through smart home management.

These research hotspots combine different fields to explore the intrinsic relationship between digitalization and green development from different research perspectives.

4   CONCLUSION

Through the analysis of previous domestic and foreign research on digitalization and green development, it can be observed that currently, both domestic and foreign scholars are in the initial stages of combining these two areas of study. The current focus of research is primarily on the role of digitalization in promoting green development. In the implementation of the main division, it is primarily divided into two aspects.

First, the enterprise, as the main driver of digitalization, analyzes the impact of digitalization on the green development of enterprises and their environmental performance. Through the study of the intrinsic mechanisms, it was found that enterprises can enhance their level of digitization to acquire more innovative resources, thereby promoting green innovation. Second, this study examines the role of the government in promoting digitalization and its impact on the efficiency of urban green development. The findings suggest that digitalization has a significant spatial spillover effect, leading to an increase in GDP not only in the local city but also in neighboring cities. Furthermore, the study reveals that industrial digitization plays a positive moderating role in enhancing the city's GDP.

The division from the target area is mainly divided into two aspects:

First, let's discuss agriculture. The digital transformation of agriculture plays a crucial role in promoting its high-quality development. The extent of digital financial coverage, the depth of utilization, and the level of digitization all have a significant impact on the high-quality development of agriculture. Secondly, the digital economy has led to increased investment in industrial research and development (R&D) and innovation output. This has effectively raised the level of technological innovation and promoted the development of green products and processes. As a result, it has facilitated the transformation and upgrading of industries towards a more environmentally friendly approach.

Through analysis and summary, it can be found that existing scholars lack breadth in studying the relationship between digitalization and green development. Under normal conditions, digitalization has a facilitating role in green development. However, the relationship between the two under other conditions is not clear, and the mechanism between digitalization and green development has not been thoroughly studied. Additionally, it has been observed that domestic scholars lack joint research in the field combining the two topics. Furthermore, there is a lack of association between the two articles in the research field. Therefore, in future research on digitization and green development, it is important to focus on analyzing the mechanisms. The relationship between the two is examined in various situations while also being analyzed in conjunction with other key articles to clarify the underlying connection between them and lay the groundwork for subsequent in-depth research.

5   ACKNOWLEDGMENT

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