

Research Status on Enterprise Digitalization, Green Transformation, and Their Collaborative Development

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Abstract

Corporate digitalization and green transformation have become two core trends for enterprises to enhance quality and efficiency. In recent years, there has been a sharp increase in research related to corporate digitalization and green transformation, making it necessary to deepen academic and industrial understanding of these dual transitions. Against the backdrop of rapid digital technology advancement and the global wave of green transformation, the deep integration of corporate digitalization and greenization has become an irreversible trend and a key driver of high-quality economic development. Therefore, under this context, this paper systematically reviews the existing literature on the research status and driving factors of corporate digitalization and greenization, analyzes the current progress in research on their synergistic transformation, and proposes future research directions for the collaborative development of digitalization and greenization in enterprises. The aim is to provide references and insights for studies on the integrated development of corporate digitalization and greenization, while also offering new evidence and analytical perspectives for research in this field.

Keywords

Digitalization; Enterprise Greening; Synergistic Transformation; Research Status.

1. Introduction

With the advent of the new-generation technological revolution and the era of industrial upgrading, the digital economy has surged forward. The integration of the digital economy and the real economy has unleashed tremendous energy, making digital transformation a core driver for corporate upgrading, quality improvement, and efficiency gains. At the same time, the high energy consumption inherent in digitalization cannot be overlooked. Green development has become a global consensus, and the proposal of the “dual carbon” goals underscores China’s firm commitment to green and low-carbon transformation. Enterprises are undoubtedly the key economic agents in this green transition. Currently, China’s economy has shifted to a stage of high-quality development, with digitalization and greenization emerging as two core trends driving this progress. The deep integration and synergistic development of these two forces have become an inevitable choice under China’s new development philosophy. Digitalization empowers greenization, while greenization guides digitalization-the two reinforce and support each other[4]. Their synergy holds profound significance for long-term economic development and provides an ideal transformation pathway for enterprises. Digital-green synergy will inject new vitality and momentum into corporate growth, helping companies address resource constraints and environmental pressures while enhancing their competitiveness. Therefore, how to promote the synergistic

transformation of corporate digitalization and greenization to lay the foundation for high-quality enterprise development has become an urgent issue to address.

From a policy perspective, the report to the 20th National Congress of the Communist Party of China called for “promoting green and low-carbon production and lifestyles” and “accelerating the development of the digital economy and promoting the deep integration of the digital and real economies.” These directives form the core requirements for digital and green development. Meanwhile, in November 2022, the Cyberspace Administration of China, along with the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Ecology and Environment, and the National Energy Administration, jointly announced the launch of comprehensive pilot programs for the synergistic transformation of digitalization and greenization (dual transformation). They explicitly stated that these pilot initiatives are important measures for building a modern industrial system and accelerating the transition to green development. Over the years, the state has successively introduced a series of policies, such as the 14th Five-Year Plan for National Informatization and the Overall Layout Plan for Digital China Construction, which further clarify the synergistic relationship and significant role of digitalization and greenization in mutually reinforcing and supporting each other. Therefore, researching the synergistic transformation of corporate digitalization and greenization holds significant policy relevance and practical importance, providing valuable insights for governments and enterprises in formulating more scientific and effective strategies and policies for dual transformation.

From a practical perspective, the synergistic transformation of digitalization and greenization serves as a critical pathway for enterprises to achieve sustainable development and a key means to improve resource allocation efficiency and promote green growth. However, as the pace of transformation accelerates, the exploration and development of corporate digital-green synergy face numerous challenges, such as mutual constraints between digital and green initiatives, transitional frameworks that remain exploratory, industrial chains that are not yet fully interconnected, and transition mechanisms that are not yet mature. As the core entities in socio-economic operations, how enterprises can effectively realize digitalization driving greenization and greenization guiding digitalization represents a key scientific issue in advancing digital-green synergy. This has also become a cutting-edge and widely discussed topic of broad interest across various sectors of society.

Therefore, researching the synergistic transformation of corporate digitalization and greenization carries significant practical relevance, providing theoretical support and guidance for corporate “digital-green synergy” practices. In light of this, this paper systematically reviews existing literature on the current research status and driving factors of corporate digitalization and greenization, analyzes the progress in studies related to their synergistic transformation, and proposes future research directions for corporate digital-green synergy. On one hand, by integrating fragmented studies on corporate digital and green transformation at the current stage, it synthesizes the connotations, research methodologies, and driving factors of such transformations, thereby enhancing researchers’ understanding of their key elements. On the other hand, through the systematic review of relevant literature and research progress, it provides an in-depth analysis of the potential for integrated development and offers insights into the driving factors behind such integration. This study aims to serve as a reference and provide insights for research on the integrated development of corporate digitalization and greenization, while also contributing new evidence and analytical perspectives to this field of study.

2. Research on Corporate Digital Transformation

With the in-depth development of the digital economy, traditional industrial models have undergone transformations, evolving into digital industrialization and industrial digitization, which have become important engines for high-quality economic development. As the core entities in economic operations, enterprises are inevitably compelled to leverage emerging technologies for digital transformation during this process.

Research on corporate digital transformation has emerged as a cutting-edge and hot topic in academic studies. To further investigate the research landscape of “corporate digital transformation” domestically and internationally, search terms including “enterprise” and “digital transformation” were used in the CNKI database, limited to CSSCI-indexed journals, and “enterprise” and “digital transformation” were used in the Web of Science Core Collection database, limited to SCI-indexed journals. After detailed screening and deduplication, by the end of 2024, a total of 1,119 Chinese articles and 1,150 English articles were obtained. Research on corporate digital transformation remained relatively limited between 2011 and 2019, but the volume of publications began to rise steadily after 2019.

To date, the number of publications on corporate digital transformation continues to grow rapidly, indicating that the field is still in a phase of vigorous development. Research on corporate digital transformation, both domestically and internationally, primarily focuses on its relationships with financing constraints, corporate innovation, environmental performance, corporate governance, technological innovation, and green innovation.

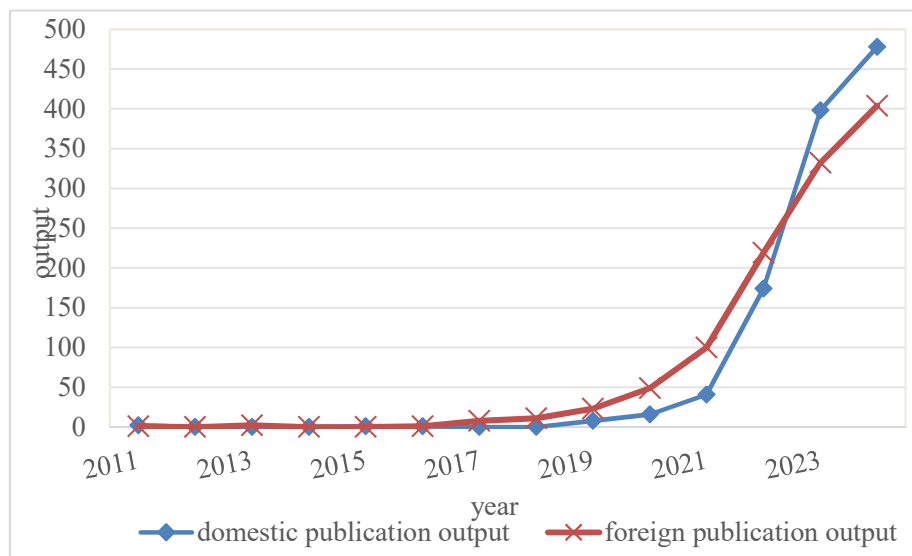


Figure 1. Trends in Chinese and English Publications on Corporate Digital Transformation

2.1. The Connotation of Corporate Digital Transformation

Corporate digital transformation involves not only the application of digital technologies and the adoption of digital tools but also constitutes a profound organizational transformation. From a broader perspective, digital transformation represents a systemic and organization-wide process that encompasses changes across multiple dimensions of the enterprise, including business operations, organizational structure, and corporate culture.

Through a review of the literature, it has been found that existing studies hold different understandings of the connotation of corporate digital transformation, which can generally be analyzed from two perspectives:

From the perspective of digital technology application, Berman (2012) pointed out that digital transformation leverages digital technologies to shift traditional enterprises from product-

oriented business models to service-oriented ones[1]. Qi Yudong et al. (2020)[17] argued that digital technologies comprise information technology, internet, and big data, among others, through which enterprises achieve their own digital transformation. Wu et al. (2021) stated in their research that corporate digital transformation is not merely the digitization of data and materials, but rather involves leveraging cutting-edge digital technologies and hardware systems to promote the digitization of production factors and processes within enterprises. Yang Yanxin and Gao (2024)[30] emphasized that digital transformation requires enterprises to build upon digital technologies, digital products, and digital platforms to achieve a comprehensive reshaping from products and services to customer experience, thereby creating new business concepts, models, domains, and value.

From a corporate strategy perspective, Christian et al. (2015) argued that companies need to establish management practices to manage transformations in key areas such as products and processes, as well as changes in organizational structure. They emphasized that developing a digital transformation strategy is a crucial approach to integrate the coordination, prioritization, and implementation of digital transformation across the organization. Marcus et al. (2019) maintained that enterprises must address digital transformation simultaneously across multiple dimensions, including strategy, organizational structure, operations, and culture. M Ghobakhloo et al. (2021) characterized digital transformation under Industry 4.0 as a strategic business transformation that relies on the institutionalization and integration of various combinations of modern information and digital technologies (IDT)[6], such as artificial intelligence and data analytics. Pauline et al. (2024) defined digital transformation as encompassing business models and digital strategy, operations and processes, people and culture, as well as the use of digital tools and data to effectively execute tasks or create products and services.

2.2. Driving Factors of Corporate Digital Transformation

Research on the driving factors influencing corporate digital transformation has become a prominent topic in recent years, though scholars have yet to reach a consensus. Tornatzky et al. (1990)[22] proposed the Technology-Organization-Environment (TOE) theoretical framework, which explains technological innovation, adoption, and diffusion from internal and external enterprise perspectives through three dimensions: technological, organizational, and environmental contexts. Since its introduction, the TOE framework has been widely adopted by scholars in studies related to influencing factors and related areas. As complex systems within the broader socio-economic landscape, enterprises are influenced by multiple interacting factors. Therefore, this study will review the literature from three distinct perspectives-technological, organizational, and environmental contexts-that impact corporate digital transformation.

First, regarding technological factors, AS et al. (2015) indicated that digital technologies promote advanced manufacturing industries to enhance production processes through improvements in products and processes, thereby facilitating digital transformation in manufacturing. Zhang (2020)[33] pointed out that corporate digital transformation requires the support of emerging digital technologies and must be driven through the application of these technologies. Vial (2021)[24] argued that enterprises can leverage digital technologies such as artificial intelligence and big data to transform their operational processes and establish intelligent analytical and decision-making management systems, thereby advancing the digitization of corporate operations. Liu et al. (2024)[15] stated that digital technological innovation capacity not only provides enterprises with new solutions and business models but also offers possibilities for exploring new markets and business domains.

Second, regarding organizational factors. Elements at the organizational dimension are related to enterprise production, firm characteristics, governance structure, and executive attributes,

among others. Peter C. Verhoef (2021)[25] argued that a key consideration for achieving digital transformation is adapting to the organizational changes required for digital shifts, particularly concerning organizational structures that can flexibly respond to digital transformation. Li et al. (2022)[11] pointed out in their research that the influencing factors at the organizational dimension are mainly reflected in two aspects: the transformation of management models and the improvement of production processes, which provide crucial space for advancing digital transformation in the manufacturing sector. The research findings of Li et al. (2023)[10] indicate that the attribute of organizational digital literacy-encompassing employees, senior management, and hardware/software infrastructure-is a vital condition for digital transformation. Lin et al. (2023)[13] suggested that a flexible and efficient organizational structure can effectively reduce uncertainties during the digital transformation process, facilitating the transition by efficiently identifying and allocating resources and coordinating various functional departments within the organization. Wang et al. (2024)[26] found that CEO discretion can significantly influence a company's digital transformation. Hou et al. (2024) proposed that organizational resilience helps drive organizational optimization practices such as technological management innovation and internal control, providing new impetus for the synergistic transformation of digitalization and greening in enterprises.

Finally, regarding environmental factors. The environmental school of strategic management theory emphasizes that the motivation for corporate strategic transformation primarily stems from external environmental influences. Yang et al. (2023)[29] argue that a favorable digital environment provides enterprises with more resources and services, motivating them to adjust their strategies to better adapt to changes in the external environment.

3. Research on Corporate Green Transformation

With the growing severity of environmental pollution and climate change, there is a clear public recognition that rapid economic development cannot be achieved at the expense of environmental degradation. Consequently, the philosophy of green development has gradually entered public consciousness.

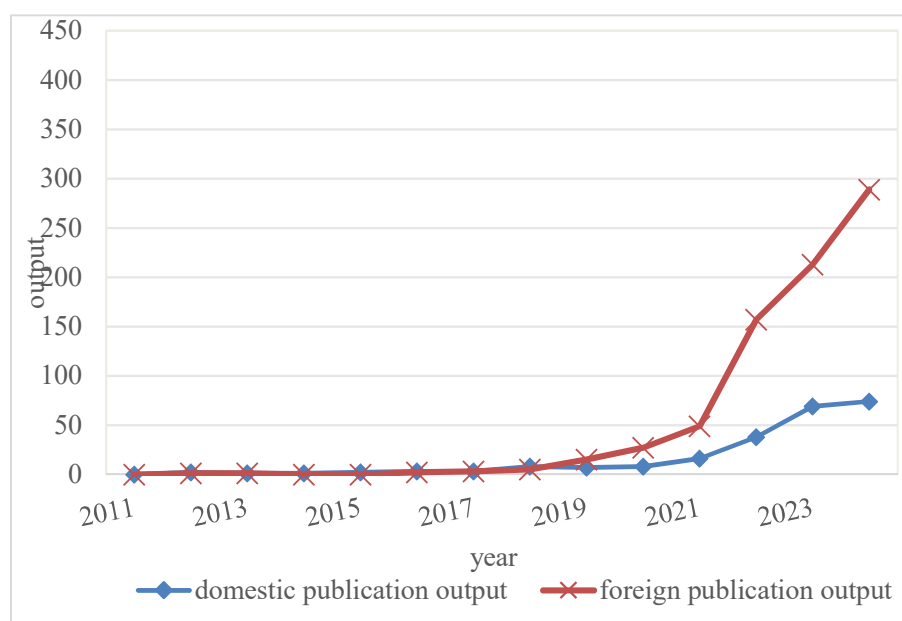


Figure 2. Trends in Chinese and International Publications on Corporate Green Transformation

To further investigate the research landscape of “corporate green transformation” domestically and internationally, the search terms “enterprise” and “green transformation” were used in the CNKI database, limited to CSSCI journals, and “enterprise” and “green transformation” were used in the Web of Science Core Collection database, limited to SCI journals. After detailed screening and duplicate removal, 232 Chinese publications and 762 English publications were obtained. As shown in the figure below, the number of publications on corporate green transformation continues to grow rapidly, indicating that this field is in a stage of vigorous development. Research on corporate green transformation, both domestically and internationally, mainly focuses on its relationships with the digital economy, ESG performance, green technology innovation, environmental regulations, and other aspects.

3.1. The Connotation of Corporate Green Transformation

With the increasingly severe global environmental issues, green development, as the core concept of sustainable development, is gradually becoming a common goal pursued by nations worldwide. It not only represents a new model of economic growth but also signifies a profound rethinking and reform of traditional development patterns. In 2015, the concept of “green transformation” was first introduced at a meeting of the Political Bureau of the CPC Central Committee, emphasizing the urgency of comprehensive green transformation across all sectors of society and the critical need for green development. The proposal of China’s “dual carbon” goals has further solidified the nation’s determination to advance green development and address climate change.

The “Spaceship Earth” theory proposed by American scholar Kenneth Boulding (1966), along with subsequent discussions on steady-state economy, green economy, and ecological economy by Daly, Pearce, and others, are considered the intellectual origins and initial conceptualizations of green development theory. Markard et al. (2012) conducted a review and analysis of sustainable transition literature, systematically organizing relevant conceptual frameworks, which paved the way for new conceptual developments and served as stepping stones toward the maturation of sustainability transition research. Domestic research on green transition initially focused on cities. However, in reality, enterprises are the primary agents driving economic green transition, making corporate green transformation in China an urgent imperative. Fu et al. (2016) argued that urban green transition has become one of the key strategies for promoting sustainable development[5].

Under the framework of sustainable development principles, urban green transformation is dedicated to constructing synergistic relationships among urban resource endowments, promoting coordinated urban development across social, economic, and environmental dimensions, thereby maximizing overall benefits throughout a city’s lifecycle. Liu et al. (2015)[14] categorized corporate green transformation into three dimensions, proposing that achieving corporate green transformation involves coordinating and managing relationships between enterprises and nature, enterprises and society, as well as internal corporate relations, with the goal of promoting “dual health” outcomes. Cao Yu et al. (2023) pointed out that green transformation represents a cutting-edge and visionary green development model that is gradually becoming a core strategy for enterprises pursuing sustainable development[2]. It is grounded in the concept of green development, oriented toward resource efficiency and environmental friendliness, driven by green innovation as its core momentum, and implemented through comprehensive green transformation throughout the entire production process. This model not only focuses on improving economic performance but also emphasizes the optimization of environmental performance, aiming to achieve a win-win situation of ecological environment improvement and high-quality economic and social development.

3.2. Driving Factors of Corporate Green Transformation

The driving factors of corporate green transformation, as one of the key research areas in studying corporate green transformation, hold indispensable value for gaining deeper insights into its inherent mechanisms and providing robust decision-making support for enterprises promoting green transformation. Numerous factors influence corporate green transformation, and scholars have explored them from various perspectives. This study will review the literature from three distinct dimensions-technology, organization, and environment-that affect corporate green transformation.

From a technological perspective, for enterprises to undertake green transformation, particularly in the process of resource utilization, it is essential to balance economic benefits with environmental protection, adhere to the principles of the circular economy, and achieve energy conservation, consumption reduction, and emission cuts. This necessitates intensified efforts in green technology innovation and enhanced capabilities in this area. Yue et al. (2017)[31] argued that technological innovation has become a crucial direction for achieving industrial green transformation in China, with the effects of different technological innovation approaches exhibiting heterogeneity across industries. Fan et al. (2021) pointed out that innovation drive serves as both the focal point and breakthrough in green and low-carbon transformation development[3], and the level of technological innovation is a significant factor influencing green transformation. Xiao et al. (2023)[28] posited that big data application capability plays a pivotal role in promoting corporate green strategic development. The stronger the big data application capability, the better enterprises can accurately predict and grasp consumers' green demands, gain deep insights into the market competition environment, and promptly respond to changes in government regulatory policies, thereby guiding enterprises to make more optimized green strategic decisions and significantly enhance the speed and proactiveness of their green strategic responses. Hou et al. (2024) stated that the technological management capability can reduce the risks that accompany green innovation[7], can improve resource allocation for green innovation, and can coordinate the relationship between green technology capability and the enterprise's green innovation strategy and sustainable development goals.

Regarding organizational factors, these encompass firm characteristics, managerial cognition, executives' environmental experience, among others. Ren et al. (2020)[18] found that after initially forming the concept of green transformation, corporate management does not stop there but rather implements a series of organizational changes and concrete measures to ensure this concept takes root. In this process, corporate strategy not only plays a crucial guiding role but also continuously steers the enterprise along a transformation path aligned with environmental and practical considerations. The backgrounds of top executives within the organization influence the enterprise's strategic direction. The existence of organizational slack can provide a buffer for transformation and reduce associated risks (Wu, 2023; Xiao, 2024; Kang, 2024)[28]. Institutional pressure and technological compatibility influence the organization's adoption behavior regarding green innovation, thereby promoting green development (Siyal, 2023)[19]. Simultaneously, surplus resources empower managers. Bolstered by ample resource reserves, they can engage in green R&D and green manufacturing activities. This helps reduce constraints on innovation resources and performance pressure, mitigate enterprise innovation risks, enhance innovation tolerance, and vigorously promote the active adoption of green management practices by enterprises (Wu, 2021)[27].

Finally, from the perspective of environmental factors, these include the institutional environment, market conditions, and economic development status, among others. Zeng and Li (2022)[32] pointed out in their research that market green pressure is a significant factor driving enterprises to engage in green ambidextrous innovation. Based on stakeholder theory, market green pressure primarily originates from customers, suppliers, and competitors. Lei et

al. (2020)[9] argued that when enterprises adopt cleaner and more energy-efficient production methods to legally avoid pollution discharge fees, obtain government environmental subsidies, or respond to public demands for environmental protection, it can directly alter the overall level of green transformation in the manufacturing sector. Their empirical tests also demonstrated that environmental regulations have a non-linear impact on the green transformation of manufacturing. Environmental regulations-a series of laws, regulations, and policy measures formulated by governments to protect the environment-not only constrain corporate pollution emissions but also, to some extent, drive green transformation (Kang, 2024)[8]. Government-led green certifications have a significant environmental incentive effect on enterprise green transformation (Nie, 2025)[16]. Green credit, as a major policy innovation aimed at promoting a shift in economic development models and Industrial Green Transformation (IGT), can facilitate green transformation (Song, 2024)[20].

4. Research on the Synergistic Development of Digitalization and Greenization

In December 2021, the Cyberspace Administration of China released the “14th Five-Year Plan for National Informatization,” which explicitly called for “advancing the construction of an ecological civilization with green intelligence and promoting the synergistic development of digitalization and greenization.” Following this, reports on digital-green synergistic development have been successively released, and domestic scholars have progressively initiated research in this field.

Zheng et al. (2021)[34] employed the entropy method to measure the digital economy index and green economy index respectively, and constructed a modified coupling coordination degree model to calculate the coupling coordination degree between these two indices, using this to represent their level of synergistic development. Lin (2023) established an evaluation indicator system to measure the development levels of industrial digitalization and green technology innovation, utilized a coupling coordination degree model to assess their coupled and coordinated development level[12], and applied exploratory spatial analysis to investigate the spatial effects of their coordinated development. Zhou et al. (2023)[35] constructed a composite system coordination indicator system for corporate digitalization and greenization to measure their integrated development, and empirically verified that the development of urban digital finance significantly enhances the integrated development of corporate digitalization and greenization. Tian et al. (2023)[21] used data from A-share listed companies and applied a simultaneous equations model to empirically examine the bidirectional relationship between corporate digitalization and greenization, demonstrating that digital transformation promotes corporate green innovation while green innovation simultaneously drives corporate digital transformation. Umarjan et al. (2024)[23] studied Chinese manufacturing A-share listed companies from 2010 to 2020, investigating the mutually reinforcing synergistic relationship between corporate digital transformation and green transformation based on synergy theory, and explored their synergistic effect in promoting common prosperity within enterprises.

5. Conclusion

In summary, while scholarly research on “digital transformation” and “green transformation” is substantial and has yielded a series of achievements with a growing body of literature in recent years, studies that integrate the two remain scarce. Due to the relatively recent introduction of policies promoting the synergistic development of digitalization and greenization, research in this specific area is even more limited. Currently, studies on the synergistic development of digitalization and greenization are gradually becoming a hot topic

in academia. Among various methodologies, the coupling coordination degree model has been widely employed as an effective analytical tool for measuring the level of synergistic development between the two.

However, although certain research achievements have been made in this field, studies on the subsequent effects of digital-green synergistic development remain in the exploratory stage, requiring more scholars to engage in in-depth research and discussion. Nevertheless, many researchers have already entered this field, and their findings provide important insights for future studies on digital-green synergy. These works not only enrich our understanding of the coordinated development of digitalization and greenization but also offer valuable experience and reference for researching its long-term impacts. Furthermore, studies on the driving factors of corporate digital and green transformation, as well as their correlation with corporate performance, are already substantial and hold significant reference value. Currently, the synergistic transformation of corporate digitalization and greenization has become an irreversible trend and a crucial path for enterprises to achieve high-quality development. Therefore, exploring the driving factors behind this synergistic transformation and conducting a preliminary investigation into its antecedents holds considerable referential importance.

In future research, efforts could focus on developing more accurate and effective methods for measuring corporate digital-green synergistic transformation. Approaches such as econometric empirical studies, fuzzy-set Qualitative Comparative Analysis (fsQCA), grounded theory, and machine learning could be introduced to explore the driving factors and realization pathways of this synergistic transformation. Additionally, empirical research examining the relationship between corporate digital-green synergy and subsequent performance should be conducted.

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