



Leveraging Digital Transformation and Artificial Intelligence for Enhancing Corporate Environmental Performance: A Focus on Innovation, Optimization, and Governance Mechanisms

Yilin Yan

The University of Warwick, Coventry, UK

reginayan08@outlook.com

Abstract. With the progress of the fourth industrial revolution, digital technology has been widely used in all walks of life. More and more companies are beginning to integrate digitalization into their strategies. Digital transformation (DT) has emerged as one of the core strategies companies can use to enhance their competitiveness and innovation capabilities. It is a high-level transformation in deepening digital upgrading and transformation, aiming to create a new business model by reshaping the company's core business. Digital transformation can inspire companies to actively seek and implement new value-creation strategies and use the development of digital technology and its supporting capabilities to create a dynamic digital business model. In promoting digital transformation, business applications, process optimization, organizational culture construction and other work are closely linked. This paper will focus on the specific impact path of digital transformation on corporate environmental performance, and systematically analyze how to promote corporate environmental sustainability through the synergy of different paths.

Keywords: Digital transformation, digital environment, environmental performance.

1 Introduction

With the continuous advancement of information technology, digital transformation has redefined the operating model of enterprises and prompted them to respond quickly to changes in a global and digital environment. Environmental performance, as an important part of the sustainable development strategy of enterprises, is an environmental management tool and an important means to solve environmental problems. In this process, in addition to paying attention to financial and market performance, enterprises are also paying more and more attention to improving environmental performance. Enterprises are important carriers of digitalization and the largest subject of environmental pollution, especially resource-intensive firms with high energy consumption [1]. Based on the principle of "whoever pollutes, whoever governs", enter

© The Author(s) 2025

S. M. Zabri et al. (eds.), *Proceedings of the 2025 4th International Conference on Big Data Economy and Digital Management (BDEDM 2025)*, Advances in Intelligent Systems Research 191,

https://doi.org/10.2991/978-94-6463-710-6_14

prises should assume the primary responsibility for environmental governance. The relationship between DT and environmental performance has been widely discussed recently, but the results are mixed. Due to the complex impact mechanism of digital transformation, its environmental performance results are insignificant [2]. Therefore, it is of great practical significance to deeply explore the impact mechanism of DT on corporate environmental performance and the challenges faced in the implementation process.

2 Literature Review

This section will be discussed in corporate environmental performance and digital transformation.

2.1 Corporate Environmental Performance

In recent years, problems such as climate warming, air pollution and the depletion of natural resources have intensified. Since enterprises are the largest contributors to environmental pollution, more and more countries and governments have begun to pay attention to corporate environmental performance and urge enterprises to adopt sustainable development initiatives. Environmental performance (EP) refers to an enterprise's performance in pollution prevention, resource consumption, and prevention of environmental damage, including its efforts and results. It is an important indicator for measuring the degree of sustainable development of a firm [3]. Dragomir describes EP measurement as an integrated management process that requires technical capabilities, employee training, strict compliance, stakeholder communication and supply chain management [3]. Table 1 shows the core indicators of environmental performance and their meanings. From a strategic perspective, in addition to meeting legal and policy requirements, companies also need to incorporate environmental protection into corporate management to comply with their long-term planning for environmental protection strategies. According to the natural resource base theory (NRBV), enterprises can enhance their competitiveness by implementing specific environmental strategies and improving environmental awareness, and high levels of environmental awareness can be transformed into higher economic returns [4].

Table 1. Measures of environmental performance

INDICATOR	DEFINITION	IMPACT ON ENVIRONMENTAL PERFORMANCE
CARBON EMISSIONS	Total annual carbon dioxide emissions	Reflects a company's ability to control greenhouse gas emissions
WATER CONSUMPTION	Total annual water consumption	Reflects the water resources management efficiency of company
ENERGY EFFICIENCY	Total energy consumption to output ratio	Shows how efficiently a company is using energy
WASTE MANAGEMENT	Waste recycling rate Waste disposal volume	Reflects a company's effectiveness in waste management

2.2 Digital Transformation

Vial adopts grounded theory and believes that digital transformation (DT) is a transformation process in which enterprises rely on digital technology to trigger disruptive changes in physical attributes, optimize traditional business processes, and become a new enterprise [5]. Digital technologies include the Internet of Things (IoT), artificial intelligence (AI), big data analysis (BDA), blockchain and other information and communication technologies (ICT). These technologies can serve as tools for business management and digital innovation, promoting enterprise connectivity, communication, and automation [6], bringing changes to the entire company's business model, such as existing products, processes and organizational structure. Based on a theoretical perspective, digital transformation has experienced three development phases: Digitization, Digitalization and Digital transformation [7]. From just focusing on the digital processing of things to focusing on business model updates at the strategic level, digitalization is made possible, the company's new core competitiveness is built, and new business models are nurtured. Figure 1 shows the triggering factors of DT, organizational structure changes and strategic responses, and the positive and negative impacts that companies may face after implementing DT.

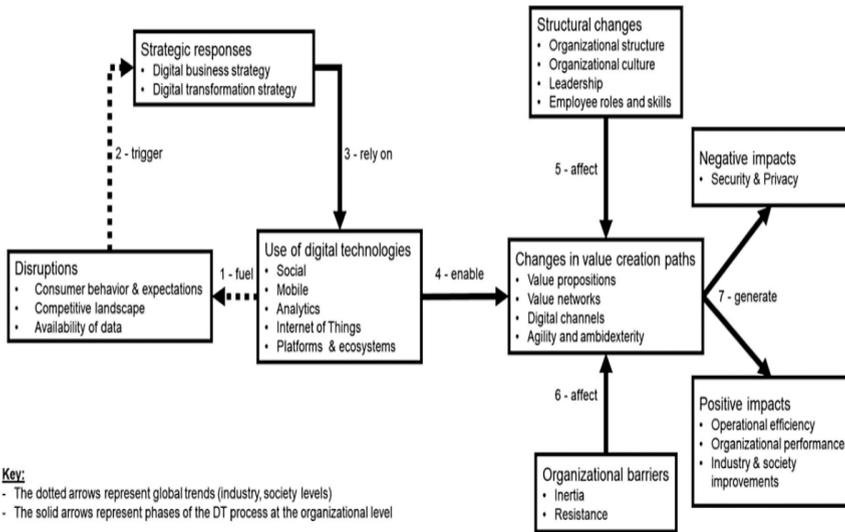


Fig. 1. Components of the digital transformation process [5]

Digital transformation emphasizes the deep integration of technology and business, and the use of technology to promote comprehensive changes in strategy, culture, and organizational structure to achieve systematic upgrades of enterprises in the information age. Fichman et al. believe that DT is a process in which firms promote all-round changes in enterprises through digital applications in products, operations, and governance [8]. Based on this framework, digital transformation can be divided into three core dimensions: technology innovation, digital process and digital governance. These dimensions not only reflect the application of digital technology in

different areas of the firm, but also reveal its importance to the overall transformation of the company.

Digital technology innovation is mainly reflected in the digital upgrade of products and services. Horlach et al. believe that digitizing company products and services replaces or enhances physical products and provides new ways to interact with customers [9]. Digital processes are how businesses optimize and improve business processes through the use of information technology and automation tools. It emphasizes the transformation from traditional manual operations to automation and intelligence [10]. Hanisch et al. believe that digital governance is a new form that uses digital technology and resources to achieve automated control, incentives, coordination and trust mechanisms [11].

3 Analysis

In corporate performance, environmental performance usually influenced by digital technologies innovation and digitization of processes.

3.1 Digital Technology Innovation

With the rapid development of digital technology, digital technology innovation promotes changes in the product and service sector with unprecedented power. From the design optimization of smart products to managing the whole product lifecycle, it provides a new perspective and solution for improving environmental performance and realizing sustainable development. Companies enhance market competitiveness by developing and applying digital technologies like IoT and BDA. These technologies enable products and services to achieve more efficient resource utilization and lower environmental impact during their lifecycle. Take the sustainable smart product service system as an example, which integrates smart connected products and digital services [12]. By allocating resources and analyzing user feedback, product design is continuously optimized and extends product life. The introduction of intelligent circulation systems enables the redesign, reuse and recycling of materials and components. This can effectively reduce the consumption of non-renewable resources and improve environmental performance.

In addition, digital technology innovation realizes the interaction between digital products and the environment at different life cycle stages by constructing an environmental interaction model. This model not only optimizes the resource allocation of products at different stages, but also significantly reduces energy consumption and pollution emissions, such as the design of intelligent high-speed trains. Figure 2 shows the environmental interaction model of high-speed trains from design to recycling. Zhang et al. found through this model that intelligent trains can optimize transportation routes and reduce empty load rates through intelligent energy monitoring systems, thereby reducing energy consumption and carbon emissions [13].

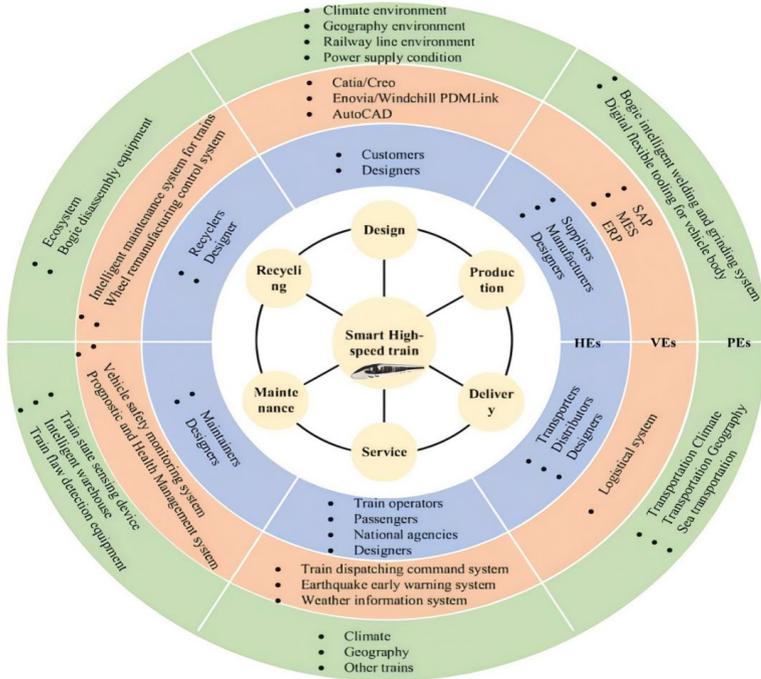


Fig. 2. Through-life cycle environmental interaction model of high-speed trains [13]

As a typical representative of digital products in life, intelligent vehicles further demonstrate the contribution of digital technology in optimizing resource utilization and promoting green transportation. Its combination of electrification and autonomous driving technology has dramatically reduced fuel consumption and carbon emissions. At the same time, intelligent vehicles can monitor the health of batteries in real time through the built-in battery management system and automatically notify the recycling centre before the energy is exhausted [14]. Recycled batteries can be used for energy storage or other low-power scenarios to extend their life cycle and reduce resource waste.

3.2 Digitization of Processes

In the context of firms pursuing sustainable development goals, the digital transformation of business processes is becoming a core path to improve environmental performance. It is the prerequisite for enterprises to launch digital products and services. Digital technologies and the increasing availability of data necessitate adjusting procedures, especially when affecting various lines of business [15]. Therefore, processes need to develop based on the kind of company activities and value chain stage after transformation. The company uses technological means to conduct comprehensive digital optimization of the company's production, operations and supply chain pro-

cesses. For example, through the use of sensors combined with IoT technology, complex integration, remote control, and automation of operational processes can be enabled to achieve significant business improvements and streamline operations [16]. It also plays a key role in improving corporate efficiency while reducing resource waste and pollution emissions.

Unwanted pollutants generated by enterprises during the production process will be removed through technical means during the treatment stage. Traditional manufacturing industries usually rely on end-of-pipe treatment technologies during production to reduce direct environmental impact through pollutant treatment facilities. As digital technology intervenes in the production process, front-end cleaner production technologies spurred by digital transformation have become the crucial method to reduce pollutants [17]. It can help enterprises significantly reduce pollution emissions during the production process and break through the emission reduction path of pollution first and treatment later. For example, applying digital technology for real-time monitoring and analysis ensures that energy consumption during the production process is always within established thresholds, thereby improving environmental performance [17]. Wen et al. further deepened this view through mathematical models [18]:

$$Pollution_{ijpt} = \alpha + Digitalization_{jpt}\delta + X_{ijpt}\beta + Z_{1pt}\gamma_1 + Z_{2jt}\gamma_2 + \mu_p + \lambda_t + \varepsilon_{ijpt} \quad (1)$$

Among them, *Pollution* is a proxy variable for corporate environmental performance; *Digitalization* is the core explanatory variable, it refers to indicators of digital transformation at the industry level. X represents the firm's control variables, and Z_1 and Z_2 represent regional and industry characteristics control variables. μ_p and λ_t represent region and time fixed effects; ε is the error term. δ refers to the influence coefficient of DT on corporate environmental performance. If δ is significantly negative, digital technology has significantly reduced the pollutants generated in the front-end production process. It indicates that digital intervention in the production process can transform the company's pipe-end governance of environmental performance into front-end control, positively impacting environmental performance.

In addition, digitalization enables flexible production and intelligent avoidance based on connected devices and systems. Smart factories introduce advanced production equipment, automation and digital systems to improve process efficiency and reduce energy waste. As the Haier smart factory case study shows, smart factories not only simplify production, logistics, and assembly processes through product modularization and auxiliary systems, but also significantly reduce energy consumption and material waste [13]. Through intelligent monitoring, scheduling and management, digital processes effectively reduce overproduction and bad inventory in traditional mass production and improve corporate environmental performance.

3.3 Digital Governance

The impact of digital transformation is not limited to improving business processes and product services; it also has a profound impact on the company's governance structure

and decision-making mechanism. As a new governance method, digital governance involves companies empowering the existing governance system and improving its governance capabilities through digital tools, means and measures. In particular, it improves corporate information transparency and promotes green innovation in companies, thereby promoting the realization of sustainable development goals. Different from simple digital process optimization, digital governance focuses more on how to optimize the company's strategic decision-making and governance mechanism through technical means, thereby having a more profound and extensive impact on the company's environmental performance.

In this era of rapid economic growth, corporate executives pursue short-term operating performance and personal wealth accumulation in the future, and usually ignore the company's long-term environmental resource management. This makes companies overuse resources in the short term to expand production and overdraw the future. In this process, digital transformation can help companies achieve long-term sustainable development by optimizing internal governance. Digital transformation can capture and intelligently analyze data from various sources through real-time data access technology, providing helpful information for decision-makers to make green innovation decisions [19]. In addition, digitalization not only optimizes the decision-making process, but also enhances EP by improving the company's information environment. Digitalization can integrate workplace and management activity information in the company to form a unified information network, which significantly improves decision-making transparency and information access efficiency [19]. This information transparency improves the internal supervision ability of the firm and reduces conflicts between management and shareholders. Xu et al. further pointed out that DT can enhance the company's decision-making ability and information transparency, prompting companies to increase the use of renewable resources based on a reasonable degree of carbon information disclosure [20]. Thus, the company's sustainable development path can be planned to achieve higher EP.

4 Variables and Models

According to the definition of digital transformation from recent research, the data and variables choose in this research domain draws some attention.

4.1 Variables

To examine the relationship between digital transformation and related research area, the recent research usually analysis the critical variables on several levels. At the firm's financial parameters, return on equity (ROE), leverage ratio (Lev), ownership structure (SOE), company size (Size), current ratio (Liq), market age (ListAge), growth potential (Growth), and total asset turnover (ATO) were managed. This paper will review the past few research papers, to provide a better understanding on the variable's measurement and the relationship between digital transformation and related topics.

4.2 Python Algorithm

In a recent paper, digital transformation was measured by using a Python algorithm to perform text analysis on relevant phrases in the sample companies' annual reports [21]. The process involved incorporating the 238 identified digitized keywords into the "jieba" word list in Python. Following this, the "Management Discussion and Analysis (MD&A)" sections of sample companies' annual reports were examined using machine learning techniques to determine the frequency of these keywords. Based on this analysis, a digitalization index for state-owned public enterprises was constructed. The index was calculated by dividing the total number of digitization-related terms by the length of the MD&A section in each report. To enhance clarity and presentation, the resulting digitization degree (DIG) was scaled by multiplying it by 10,000. A higher DIG value indicates a greater level of digitalization for the respective enterprises.

4.3 Models

In this relevant paper, authors may choose to analyze different models regarding different research topic. Based on the review of the relationship between digital transformation and firms' environmental performance, the frequent variables are usually focusing on ESG, Green innovation, and enterprise environmental management behavior [22]. In order to verify the impact of DT on the environment, the following model can be constructed:

$$ESG_{it} = a_0 + \alpha_1 DDT_{it} + a_i Controls_{it} + \sum Year + \sum Ind + \sum Firm + \xi_{it} \quad (2)$$

Where ESG_{it} represents the ESG score in year t , DDT_{it} is the corporate digital transformation level in year t . α_1 denotes the constant term, $Controls_{it}$ is the control variables and ξ_{it} is the residual term. After discussion, result can illustrate the relationship between digital transformation and environmental, social and governance performance [21]. Over this research, authors examine the relationship between digital transformation and green innovation based on these research equations:

$$G_INNO_{it} = \beta_0 + \beta_1 DDT_{it} + \beta_1 Controls_{it} + \sum Year + \sum Ind + \sum Firm + \xi_i \quad (3)$$

$$ESG_{it} = \gamma_0 + \gamma_1 G_INNO_{it} + \gamma_i Controls_{it} + \sum Year + \sum Ind + \sum Firm + \xi_i \quad (4)$$

$$ESG_{it} = \delta_0 + \delta_1 DDT_{it} + \delta_2 G_INNO_{it} + \delta_1 Controls_{it} + \sum Year + \sum Ind + \sum Firm + \xi_i \quad (5)$$

In these equations, G_INNO_{it} is the number of green patents in the year, OLS regressions with fixed time, industry, and firm effects were used to test. The results show that digital transformation and green innovation have a significant impact on environmental performance, especially in the manufacturing industry.

4.4 Artificial Intelligence and Machine Learning on Environmental Sustainability

Artificial intelligence (AI) and machine learning (ML) is one of the powerful tools to solve the issues in environmental protection. For several companies, ML's ability to identify hidden patterns and analyze large datasets provides a new way to understand and optimize waste management processes. Data-driven modelling is increasingly used to design and optimize organic waste management for greater resource circularity.

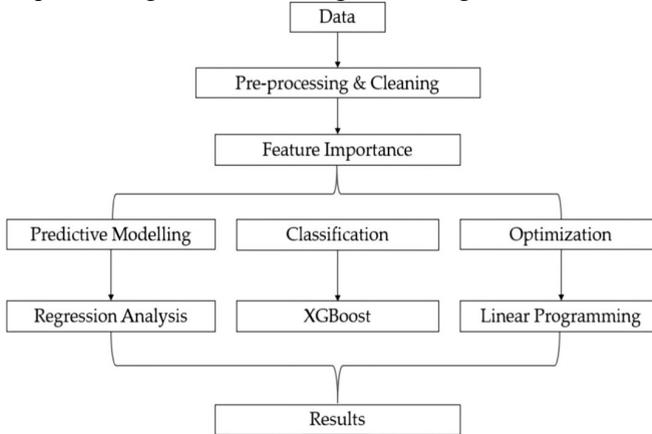


Fig. 3. Research process related to AI and ML in environmental management [23]

As shown in Figure 3, a recent article explores how AI and ML can optimize waste management (WM) strategies to improve economic efficiency and reduce environmental impact [23]. Based on the World Bank's WM dataset, the study applied a variety of machine learning techniques (such as random forests, support vector machines, XGBoost) and optimization methods, such as developing resource allocation optimization models, linear programming to predict waste generation trends (WGTs) and evaluate the economic and environmental benefits of WM methods. The results show that by introducing a diverse dataset and combining ML predictive analysis, the prediction accuracy of WGTs reached 85%, and the efficiency of resource allocation increased by 15%. These results not only provide actionable insights into WM practices, but also demonstrate the transformative potential of AI and ML to optimize operations, achieve a circular economy, and promote sustainable development.

5 Dynamic Relationships and Industries Difference

In recent years, more and more scholars have begun to pay attention to the impact of digital transformation on the high-quality development of enterprises. From the existing literature, scholars focus on the following two aspects: First, the digital transformation model level [24]. Related studies have found that the implementation of digital transformation by enterprises includes two levels: internal enterprise model and external enterprise model. The internal model mainly focuses on optimizing the internal

management efficiency of the enterprise, while the external model focuses on promoting the interactive development of multiple enterprises and improving management efficiency. Since the advent of the digital economy era, data has become an important production factor, and the wave of digital transformation has brought unprecedented impacts on the business environment of enterprises [25]. Current research usually analyzes the digital transformation of enterprises into three aspects, namely Digital Technology Innovation, Digitization of Processes, and Digital Governance. These detailed sub-items affect the environmental performance of enterprises in different aspects.

Table 2. Digital Transformation's Impact on Environmental Performance in Different Industries

MEDIATING VARIABLES	INDUSTRY SECTOR	DESCRIPTION	FUTURE RECOMMENDATIONS
GREEN INNOVATION	Manufacturing	Optimized green processes via smart equipment to reduce energy consumption and emissions.	Invest in AI-driven green technology for cleaner production and resource optimization.
	Services	Eco-friendly services, including the development of sharing economy platforms to minimize resource waste.	Develop partnerships with eco-friendly platforms to promote sustainability in services.
INTERNAL CONTROL	High-Pollution Industries	Implementation of advanced energy management systems to monitor and reduce pollution levels.	Integrate real-time IoT sensors to enhance energy monitoring and pollution reduction.
	Low-Pollution Industries	Green office management systems to track energy usage and cut carbon footprints in administrative functions.	Adopt AI-based tools for optimizing energy use in green office practices.
GREEN SUPPLY CHAIN MANAGEMENT	Retail	Reduced emissions through optimized logistics networks using AI and blockchain for transparency.	Implement blockchain for supply chain transparency and carbon footprint tracking.

As shown in Table 2, the environmental performance and digital transformation of enterprises are affected by many aspects, including different variables such as innovation, internal control, and green supply chain management. Digital transformation is a powerful driving force for improving corporate environmental performance, but its effectiveness depends on leveraging the above variables and solving industry-specific challenges. In the classification of industries, it can be seen that digital transformation is affecting many industries, especially manufacturing and service industries. These industries should give priority to green innovation, strengthen internal control, optimize supply chains, and cultivate an environmental protection culture. Enterprises in all walks of life can achieve environmental and economic benefits.

6 Discussion

Digital transformation affects environmental performance through digital technology in three core paths: digital innovation, digital process optimization, and digital governance. They promote each other and play a vital role in promoting the improvement of company products and services and achieving sustainable development goals. Table 3 shows its impact mechanism on the corporate environment and the application effects of related technologies.

Table 3. The combined impact of DT on EP

DT DIRECTION	EP IMPROVEMENT MECHANISM	ACTUAL EFFECT
DIGITAL TECHNOLOGY INNOVATION (IOT, AI, BDA)	Intelligent product optimization Life cycle management Efficient resource utilization	Reduce energy consumption Reduce carbon emissions Improve resource utilization
DIGITAL PROCESS OPTIMIZATION (IOT SENSOR TECHNOLOGY, DIGITAL PRODUCTION SYSTEMS)	Real-time monitoring, Front-end clean production technology, Production optimization	Reduce pollutant emissions Improve energy efficiency Reduce resource waste
DIGITAL GOVERNANCE (DIGITAL DECISION SUPPORT SYSTEM)	Optimize strategic decisions Improve information transparency Promote green innovation	Improve carbon information disclosure, Promote the use of green resources Promote the transformation of green enterprises

Digital technology innovation has promoted the widespread use of smart products and services, which significantly improved production efficiency and product value, and demonstrated great potential and value in environmental protection, energy conservation, and efficient use of resources. For example, the rise of smart transportation and the sharing economy further demonstrates that digital products and services promote the development of green transportation by optimizing resource allocation and reducing energy consumption. However, the digital divide problem exists between different regions and industries, which exacerbates the uneven distribution of resources. For SMEs, there may be a high barrier to entry for implementing digital technologies. Therefore, the government and industry associations should provide more technical support and training to small and medium-sized enterprises, encourage large enterprises and SMEs to establish cooperative relationships, share technology and resources, and achieve common development.

The impact of digital transformation is not limited to improving business processes, products and services; it also profoundly affects the company's governance structure and decision-making mechanism. By integrating information, the transparency of corporate information is improved, and the corporate decision-making mechanism is optimized, thereby promoting the sustainable development of the enterprise. However, although digital governance can improve information transparency and the rationality

of decision-making, it may also face challenges such as data privacy, difficulty in technology integration, and management resistance. Therefore, future research needs to explore how to solve these obstacles through technological means and promote the in-depth application of digital governance.

7 Conclusion

This article profoundly explores the impact of digital transformation on environmental performance. It reveals how the three core paths of digital technology innovation in products and services, digital processes, and digital governance can effectively promote the improvement of corporate environmental performance. However, this article mainly focuses on the theoretical analysis and case study of the impact of the three dimensions of digital transformation on environmental performance. It does not conduct empirical analysis of specific quantitative indicators, which have certain limitations. In the future, field data from more industries can be combined for more precise analysis. Additionally, this article identifies some of the barriers that companies may encounter when implementing digital transformation. Future research can further focus on the deep-seated mechanisms of the impact of digital transformation on corporate environmental performance. Explore how to overcome these barriers through effective policy and technical means to promote the deep integration of digital transformation and environmental sustainability goals.

Reference

1. Maroufkhani, P., Desouza, K. C., Perrons, R. K. and Iranmanesh, M. (2022). Digital transformation in the resource and energy sectors: A systematic review. *Resources Policy*, 76, p.102622.
2. Tao, L. and Ang, L. (2019). Corporate innovation and environmental performance - from the perspective of external governance environment. *Industrial Technology Economy*, 38(10), pp.92-100.
3. Dragomir, V. D. (2018). How do we measure corporate environmental performance? A critical review. *Journal of Cleaner Production*, 196, pp.1124-1157.
4. Tan, K., Siddik, A. B., Sobhani, F. A., Hamayun, M. and Masukujjaman, M. (2022). Do environmental strategy and awareness improve firms' environmental and financial performance? The role of competitive advantage. *Sustainability*, 14(17), p.10600.
5. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, 28(2), pp.118-144.
6. Frank, A. G., Dalenogare, L. S. and Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, 210, pp.15-26.
7. Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N. and Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, pp.889-901.
8. Fichman, R. G., Santos, B. L. D. and Zheng, Z. (2014). Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum. *MIS Q.*, 38, pp.329-343.

9. Horlach, B., Drews, P., Schirmer, I. and Böhmman, T. (2017). Increasing the agility of IT delivery: five types of bimodal IT organization. *International Conference on System Sciences*, pp.5420–5429.
10. Butt, J. (2020). A conceptual framework to support digital transformation in manufacturing using an integrated business process management approach. *Designs*, 4(3), p.17.
11. Hanisch, M., Goldsby, C. M., Fabian, N. E. and Oehmichen, J. (2023). Digital governance: A conceptual framework and research agenda. *Journal of Business Research*, 162, p.113777.
12. Li, X., Wang, Z., Chen, C.H. and Zheng, P. (2021). A data-driven reversible framework for achieving Sustainable Smart product-service systems. *Journal of Cleaner Production*, 279, p.123618.
13. Zhang, W., Gu, F. and Guo, J. (2019). Can smart factories bring environmental benefits to their products?: A case study of household refrigerators. *Journal of Industrial Ecology*, 23(6), pp.1381-1395.
14. Kusiak, A. (2018). Smart manufacturing. *International Journal of Production Research*, 56(1-2), pp.508-517.
15. Warner, K. S. R. and Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 52(3), pp.326-349.
16. Kasych, A., Yakovenko, Y. and Tarasenko, I. (2019). Optimization of Business Processes with the use of Industrial Digitalization. *IEEE Xplore*, pp.522–525.
17. Amjad, M.S., Rafique, M.Z. and Khan, M.A. (2021). Leveraging Optimized and Cleaner Production through Industry 4.0. *Sustainable Production and Consumption*, 26, pp.859–871.
18. Wen, H., Lee, C.-C. and Song, Z. (2021). Digitalization and environment: how does ICT affect enterprise environmental performance? *Environmental Science and Pollution Research*, 28(39), pp.54826-54841.
19. Li, D. and Shen, W. (2021). Can corporate digitalization promote green innovation? The moderating roles of internal control and institutional ownership. *Sustainability*, 13(24), pp.13983.
20. Xu, P., Chen, L. and Dai, H. (2023). Pathways to sustainable development: Corporate digital transformation and environmental performance in China. *Sustainability*, 15(1), p.256.
21. Lu, Y., Xu, C., Zhu, B., and Sun, Y. (2024). Digitalization transformation and ESG performance: Evidence from China. *Business Strategy and the Environment*, 33(2), p.352-368.
22. Jiang, Y., Wang, C., Li, S., and Wan, J. (2022). Do institutional investors' corporate site visits improve ESG performance? Evidence from China. *Pacific-Basin Finance Journal*, 76, p.101884.
23. Alsabt, R., Alkhalidi, W., Adenle, Y. A., and Alshuwaikhat, H. M. (2024). Optimizing waste management strategies through artificial intelligence and machine learning-An economic and environmental impact study. *Cleaner Waste Systems*, 8, p.100158.
24. Xu, P., Chen, L., and Dai, H. (2022). Pathways to sustainable development: Corporate digital transformation and environmental performance in China. *Sustainability*, 15(1), p.256.
25. Zhai, D., Zhao, X., Bai, Y., and Wu, D. (2022). Effective evaluation of green and high-quality development capabilities of enterprises using machine learning combined with genetic algorithm optimization. *Systems*, 10(5), p.128.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

