THE INTERRELATIONSHIP BETWEEN DIGITAL TRANSFORMATION AND GREEN TRANSITION IN THEORY AND PRACTICE IN VIETNAM'S ENTERPRISES

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Abstract

In the context of global sustainable development, dual transformation combining digital transformation and green transition has become a strategic requirement for businesses. The study synthesizes documents, focuses on clarifying concepts related to dual transformation, including digital transformation and green transition, and analyzes the mutual relationship between digital transformation and green transition. The study emphasizes that digital transformation plays a catalyst role in promoting green efficiency, while green transition is the driving force for digitalization. In addition, the study also systematizes a number of theoretical frameworks, including TOE (Technology-Organization-Environment), Institutional Theory, Resource Based View (RBV), and Dynamic Capabilities, to suggest a new theoretical framework for measuring and evaluating dual transformation. In addition, the study gathers initial successful results in the implementation of digital technology and green technology for energy management, emission reduction, transparent ESG reporting, and sustainable product development at three typical enterprises, including Vinamilk, Hoa Phat, and Vinfast. A limitation of this study is that it has not conducted quantitative or empirical analysis on a large data sample, so the level of statistical generalization is still limited. However, the study still has important academic contributions when systematizing and generalizing the theoretical foundation while clarifying the two-way relationship between digital transformation and green transition in the process towards sustainable development goals of Vietnamese enterprises.

Keywords: digital transformation, green transition, dual transformation, sustainable development, Vietnam's enterprises, case study.

1. INTRODUCTION

Over the past decade, two major trends shaping global development have been digital transformation and green transition. Developed economies such as the European Union (EU), the Organization for Economic Cooperation and Development (OECD), and the G20 have all considered these two core drivers for sustainable growth, high resilience, and long-term competitiveness. The concept of twin transition has been emphasized in many policy documents and research, reflecting the close relationship between digitalization and greening in the process of socio-economic development. At the global level, digital transformation is considered an important catalyst to promote carbon emission reduction, efficient resource management, and increased transparency in production and business activities. In contrast, green transition acts as a driving force for digital transformation, forcing businesses and governments to prioritize the application of digital technology to meet ESG standards, transparent reporting requirements, and increasingly stringent carbon tax mechanisms.

In Vietnam, the government has issued many important strategies, notably the National Digital Transformation Program for 2025, with a vision for 2030, and the National Strategy on Green Growth for the period 2021–2030, with a vision for 2050. At the same time, at the COP26 Conference, Vietnam committed to achieving net zero emissions by 2050. This data shows that dual transformation is becoming the focus of the process of economic integration and sustainable development. However, in terms of academics, most of the research in Vietnam currently focuses on digital transformation or green transition separately, while the interrelationship between these two processes has not been comprehensively analyzed. In this article, the research team will focus on three main objectives. First, systematizing the theoretical foundation and academic approach regarding the relationship between digital transformation and green transition. Second, analyze the implementation practices in Vietnam, focusing on macro policy and business practice aspects. Third, propose policy and corporate governance recommendations to effectively exploit the power of dual transformation in enhancing national competitiveness.

The main contributions of the paper include filling the research gap by connecting two traditionally separate research

streams, providing a suitable conceptual analytical framework for the emerging economy context, and providing useful empirical evidence for policymakers and businesses in Vietnam.

2. THEORETICAL FOUNDATIONS OF DIGITAL TRANSFORMATION AND GREEN TRANSITION

Dual transformation describes the process of green transition and digital transformation happening simultaneously and intertwined to offset a business's carbon emissions (Rehman et al., 2023). Dual transformation has been pursued by many countries around the world and is considered an essential solution to simultaneously meet the needs of economic development and solve urgent environmental problems in the future. The simultaneous integration of digital and green transformation has emerged as a key strategic imperative for sustainable development and business competitiveness. This integrated approach recognizes that sustainability and digitalization are interconnected rather than separate factors that countries and organizations must navigate together (Quimba et al. 2023). While digital transformation emphasizes the application of technology to restructure and improve efficiency in all fields, green transformation focuses on reducing greenhouse gas emissions, preserving and regenerating natural ecosystems, reversing the trend of environmental degradation, and promoting the use of renewable energy in the energy structure. Meseguer-Sanchez et al. (2024) argue that achieving climate neutrality requires a close connection between the green and digital transitions, describing this "dual transition" as the foundation for post-pandemic recovery and sustainable development. In the previous period, studies on digital and green transitions mainly developed along independent research lines, with each process analyzed separately. However, recent academic trends show a strong shift towards an integrated approach, focusing on the interrelationship between these two processes to explore the multidimensional impacts and synergistic values they bring. Research in the manufacturing industry shows that although digital transformation and green transformation are often treated separately, their integration creates synergy and addresses interdependencies more effectively (Kürpick et al., 2023). Findik et al. (2023) have emphasized that the synergy effect is particularly important in Europe, as both the digital and green transitions are top strategic priorities in EU policy, and these dual transitions are expected to be mutually reinforcing. The dual transition presents significant opportunities and challenges for sustainable development, successful implementation requires balanced approaches that maximize technological advances while protecting the environment through energy-saving activities, renewable energy integration, and circular economy principles. The dual transition presents significant opportunities and challenges for sustainable development. Successful implementation requires balanced approaches that maximize technological advances while protecting the environment through energy-saving activities, renewable energy integration, and circular economy principles (Goel et al. 2024). Quimba et al. (2023), in examining how investment, labor, science, technology, and artificial intelligence contribute to this parallel transition, identified some of the persistent challenges as including inadequate clean technology investment and skilled labor shortages.

2.1. Digital transformation

Digital transformation is a major global trend that is considered a key success factor for countries, businesses, and organizations. The use of technology to significantly improve business performance and reach is becoming a hot topic for companies globally. In essence, digital transformation is not just about applying technology but also reshaping the way organizations operate and create value for customers. Under the promotion of digital technology, digital transformation comprehensively changes socio-economic relationships and impacts all areas of organizations and businesses.

Digital transformation is defined as "a process that aims to improve an entity by making significant changes to its attributes through a combination of information, computing, communication, and connectivity technologies" (Vial, 2019). Digital transformation refers to a comprehensive change in how companies use digital technology to innovate business models and enhance value creation. It consists of three phases: digitization, digitalization, and digital transformation (Verhoef et al., 2021a). Digital transformation is not a software upgrade or a supply chain improvement project; digital transformation is a complex, multifaceted process that organizations undertake through various technology and business initiatives to realize differentiated benefits (Pani et al., 2022). Digital transformation is not a one-time process but a continuous evolution from automation to radical business model changes, with success depending on the ability of organizations to adapt to disruptive technologies (On-Piu Chan, 2020). Essentially, digital transformation represents a type of business transformation driven by emerging technologies such as AI, IoT, cloud computing, and big data analytics, where technology moves from a supporting function to enabling innovative business models and competitive advantages (Tang, 2021). These foundational technologies have been reshaping the way businesses organize production, distribution, and consumption of goods and services.

Digital transformation is considered a catalyst for comprehensive and strategic change in organizations, including synchronous changes, affecting operating structures, business models, and corporate culture, as well as management practices. Digital transformation plays an important role for businesses in improving business performance, reducing costs, promoting innovation, and enhancing competitiveness, as well as enhancing customer experience and satisfaction. In addition, digital transformation also helps businesses optimize decision-making thanks to Big Data and artificial intelligence (AI).

2.2. Green transition

Green transition is understood as "the process of changing the development model towards efficient resource use, emission reduction, environmental protection, and promoting circular economy" (OECD, 2020). The green transition is an important challenge that requires coordinated policy interventions and strategic decisions at the enterprise level. Green transition in enterprises specifically includes green product innovation, green process innovation, green space innovation, changing green practice perception, and green transition leadership (Nguyen Thi Bich Nguyet and Nguyen Thi Thu Thuy, 2025). At the policy level, Braga and Ernst (2023) argue that macroeconomic policies are needed to accelerate the green transition through three channels: strengthening price signals from externality pricing, mobilizing public and mixed capital, and mitigating social impacts on workers in polluting industries. They emphasize that the appropriate use of carbon taxes, cap-and-trade programs, and green bonds can mobilize resources for a just transition in terms of society. The green transition represents a paradigm shift towards reconciling economic development with environmental sustainability through structural changes in production, consumption, and business activities (Tasel and Bayarcelik, 2023). The goal of the green transition is to achieve environmental sustainability along with economic development (Ruan et al., 2022). Furthermore, according to UNDP (2021), green transition is an inevitable trend to achieve sustainable development goals (SDGs).

The key pillars of the green transition include (i) the use of renewable energy and reduced dependence on fossil fuels, (ii) the adoption of clean technologies and environmentally friendly production processes, (iii) the promotion of the circular economy, and (iv) increased transparency of environmental information through ESG and GRI reporting standards. Key drivers include green finance, technological innovation, human capital, government action, and environmental regulations, especially in facilitating the transition of high-carbon industries (Huang et al., 2025). The green transition must be implemented both "top-down" through alliances between states and businesses and "bottom-up" through grassroots innovation and civil society mobilization, with context being a key factor shaping the path to sustainability (Leach and Scoones, 2015).

The simultaneous implementation of digital transformation and green transition is expected to bring dual strategic benefits to businesses. New trade agreements and environmental policies such as the European Green Deal are requiring products and businesses to not only have digital capabilities but also meet strict environmental standards. Many countries around the world have integrated digital transformation and green transition into their development strategies, and Vietnam is no exception. The five most noticeable benefits when businesses successfully implement dual transformation include:First, businesses can significantly improve their negative environmental impact by optimizing production processes, minimizing carbon emissions, and increasing the use of renewable energy. Next, thanks to the application of digital technology and big data, the quality of decision-making is improved, while the efficiency of resource use (financial, human, physical) is also optimized. In addition, the dual transformation contributes to strengthening "green" competitiveness, promoting labor productivity, and encouraging sustainable innovation. Not only stopping at economic and environmental benefits, the dual transformation also creates inclusive job opportunities, helps narrow the gap, and reduces social inequality. In particular, these two transformation processes do not exist independently but create a resonance effect: digital transformation supports and accelerates the effectiveness of green transition, while green transition shapes the goals and orientations for the digitalization process to develop on a sustainable path.

2.3. Related fundamental theories

Many different approaches exist for analyzing the factors that affect each transformation process; however, in the context of dual transformation, the TOE framework, along with three supporting theories (institutional theory, resource-based view, and dynamic capabilities), provides a comprehensive theoretical framework to identify the factors influencing dual transformation.

2.3.1. TOE Framework (Tornatzky and Fleischer, 1990)

Several recent studies demonstrate that digital transformation significantly drives green innovation and sustainability through the TOE framework. The TOE (Technology-Organization-Environment Framework) theoretical framework proposed by Tornatzky and Fleischer in 1990 is one of the relatively comprehensive and complete analytical tools to evaluate the factors that promote and limit the application of new technology in organizations. The TOE theoretical framework divides influencing factors into three main groups: technology, organization, and environment. The technology factor group includes both digital capabilities (ICT readiness, digital infrastructure, AI integration capability, IoT, and cloud computing) and green capabilities (renewable energy technology, circular solutions, and emission reduction technology). Studies consistently show that digital transformation positively impacts green innovation across multiple domains, with technological and environmental factors acting as key moderators while organizational factors show varying impacts (Le, 2025; Yin, 2023). From a dual transformation perspective, this group reflects the level of technical readiness and the suitability of each technology with sustainability goals. Organizational

factors include internal characteristics such as organizational culture, governance structure, human resources, dynamic capabilities, and leadership strategy. In terms of dual transformation culture, organizational factors refer to the level of leadership commitment, training, and skill development for employees to operate digital and green systems. This group of factors shows whether the organization has enough "internal strength" to implement two transformation streams in parallel. Factors in the environmental group include institutions (regulations, policies, and ESG standards), competitive pressure (from competitors, customers, and green markets), and ecosystem cooperation (public-private partnerships and value networks). Especially in dual transformation, institutions determine the legal framework for green and digital technology, while competitive pressure and cooperation opportunities in the ecosystem shape the investment and innovation motivation of enterprises. The TOE framework is particularly significant in analyzing the interrelationship between digital transformation and green transition, considering it as a combined result of the simultaneous impact of technology, organizations, and institutional environments.

2.3.2. Instututional theory (DiMaggio và Powell, 1983)

According to DiMaggio và Powell (1983), organizations are subject to institutional pressure from three sources: (i) coercive pressure from governments and regulators, (ii) mimetic pressure from competitors, and (iii) normative pressure from society. In the context of dual transformation, these pressures are evident in the fact that businesses must both respond to government policies related to digital transformation and emission reduction targets and comply with international standards on sustainability reporting, ESG or carbon border adjustment mechanisms (CBAM). With the Coercive Isomorphism, originating from legal regulations, state policies, investor requirements or international standards, for example ISO 14001, LEED certification. Businesses are forced to comply in order to be licensed, access the market or receive capital. The second is normative isomorphism, which comes from professional standards and professional advice. For example, when industry associations or vocational education organizations recommend modern environmental management and digitalization methods, businesses follow these standards to improve their professionalism and reputation. Finally, there is mimetic isomorphism, where businesses imitate successful organizations to reduce risks and avoid falling behind. In Vietnam, the combination of the National Digital Transformation Program (2020) and the Green Growth Strategy (2021-2030) has created dual coercive pressure, while export markets requiring compliance with ESG standards create normative pressure, and pioneering corporations such as Vinfast or Vinamilk become a source of mimetic pressure for other businesses. Thus, Institutional theory provides an important theoretical foundation to explain why digital transformation and green transition have a mutual relationship and together shape the competitiveness of enterprises in the new context. It can be seen that, in the context of dual transformation, institutional theory emphasizes the key role of the State in establishing legal frameworks, issuing policies, and building standards to guide business behavior. Policies on digital transformation, Net Zero 2050 commitments, ESG standards, or the EU CBAM mechanism have become important institutional drivers, forcing businesses to simultaneously integrate digitalization and greening. This not only helps businesses enhance their legitimacy but also creates a foundation for deeper integration into the global economy.

2.3.3. Resource-based view (RBV)

Resource theory distinguishes two main types of resources: intangible assets and tangible assets. Intangible assets include information technology knowledge, artificial intelligence, product lifecycle management software, and green technology patents. Tangible assets include 5G infrastructure, smart factories, charging stations, and energy storage. These are key resources that create sustainable competitive advantages for businesses. According to RBV, rare, difficult-to-imitate, and valuable resources will create sustainable competitive advantages (Barney, 1991). When applied to the context of dual transformation, RBV shows that digital capabilities and green capabilities can be viewed as two new forms of strategic resources. Digital capabilities include technology infrastructure, big data, analytics, and digital skills among employees, while green capabilities are reflected in environmentally friendly production processes, sustainable management systems, and the ability to comply with ESG standards. These two types of capabilities do not exist independently but are complementary: digital solutions help businesses measure, monitor, and optimize resource efficiency, thereby improving green performance; conversely, green pressure forces businesses to reconfigure and invest in digital technologies to meet environmental standards (George and Schillebeeckx, 2022). Thus, under the RBV lens, the relationship between digital transformation and green transition can be understood as a dual resource integration, creating new core competencies, thereby helping businesses achieve sustainable competitive advantages in the ESG-oriented global economy. The Resource-Based View provides a theoretical framework for understanding how digital transformation serves as a strategic asset, combined with proactive environmental protection, promoting green innovation and sustainable business practices (Raghavendra and Sheethal 2024).

2.3.4. Dynamic Capabilities

Teece (2007) argues that in a rapidly changing environment, firms need to develop dynamic capabilities to sense, seize, and reconfigure resources. Sensing refers to the ability to detect new digital and green technology opportunities, for example, through R&D, observing market trends, or analyzing big data. Seizing refers to the ability to rapidly deploy identified solutions, such as setting up an IoT investment roadmap for energy efficiency or applying blockchain to ensure traceability of waste. In the context of dual transformation, this theory helps explain how firms integrate and reconfigure digital and green capabilities to achieve sustainable competitive advantage. For example, firms may sense institutional pressures and green consumption trends, then seize the opportunity by investing in digital technologies to monitor emissions, and finally reconfigure the entire production process to be both digital and green. At the same time, dynamic capabilities also emphasize the ability to learn and innovate, allowing firms not only to respond to current ESG standards or carbon taxes but also to pioneer the combination of digital and green technologies to create new business models (Brueck 2024). Thus, the dynamic capabilities theory provides an important analytical framework to explain the interrelationship between digital transformation and green transition, viewing it as a process of continuous capability reconfiguration to maintain flexibility, legitimacy, and sustainability.

Based on the TOE framework and three complementary theories, this study identifies five main groups of factors influencing the dual transformation process in enterprises. Three of these factors are internal to the enterprise: (i) strategic orientation, which reflects the leadership's vision and commitment to integrating digitalization and sustainability goals; (ii) organizational culture and behavior, indicating the readiness for innovation, risk tolerance, and adaptability of human resources; and (iii) infrastructure and technological capacity, which pertains to the level of investment in digital infrastructure and the ability to leverage new technologies for transformation. Additionally, two factors arise from the external environment: (iv) the institutional and policy environment, encompassing the legal framework and policies that support digital-green transition, including ESG standards, and (v) market pressure, driven by customer demands, international partnerships, and competitive pressures within the global value chain. Consequently, developing a research model, creating specific scales, and conducting quantitative research with a large sample of Vietnamese enterprises will be the next steps to verify and enhance the practical value of this analytical framework.

2.4. The interrelationship between digital transformation and green transition

Digital transformation and green transition are not only separate trends but also mutually reinforcing factors that help businesses and society increase competitiveness and innovation (European Commission, 2021). Tabares et al. (2025a) also emphasize that digital transformation and green transition occur in parallel and support each other, amplifying each other, leading to sustainable competitiveness for companies. In the current context, digital transformation and green transition are increasingly recognized as closely linked processes, essential for sustainable business development. The European Union has prioritized this “parallel transformation” towards a green and digital economy through initiatives such as the European Green Deal, leveraging technologies such as artificial intelligence, big data, cloud computing, and IoT (Wang et al., 2020). UNCTAD (2021) also stated that to achieve the sustainable development goals, countries need to “invest heavily in the dual transformation, while strengthening international cooperation in the fields of technology and the environment.” If digitalization ignores the green factor, businesses may fall into the trap of unsustainable growth. Conversely, if they only focus on the environment without integrating technology, businesses may fall behind in productivity, efficiency, and innovation.

Digital technology impacts green supply chain development in different ways depending on organizational structure, company characteristics, and socio-economic environment (Li et al., 2023). Digital transformation can have a positive impact, strengthening the commitment of businesses to sustainable environmental development. Many studies have shown that the digital economy plays a particularly important role in enhancing green innovation (Liu et al., 2024). Digital transformation provides powerful tools to support and significantly promote green transition in many different aspects, from controlling input factors and managing operations to improve production and business processes to developing new products and monitoring and measuring emissions. Digital technologies such as digital twins, automation, and data analysis allow businesses to perform business simulations, optimize production processes to reduce energy consumption, and increase resource efficiency. This is evidence that digital transformation guides businesses towards green production and resource saving. Technologies such as AI, IoT, and big data allow for real-time data collection, processing, and analysis, allowing businesses to monitor and measure performance indicators such as emissions, energy consumption, or product life cycles, and transparency in ESG reports. This helps green transition have a scientific basis and accurate data to implement in business operations.

Studies demonstrate that digital transformation technologies such as AI, IoT, and big data help improve operational

efficiency, reduce environmental impact, and support sustainability goals through real-time monitoring, resource optimization, and waste reduction (Raghavendra and Sheethal, 2024). This helps green transition have a scientific basis and accurate data to implement in business operations as well as make information transparent in ESG reports. Through digital platforms, digital transformation helps businesses easily reach customers, deploy and develop green products and services, convey green messages, call for green behavior, and easily demonstrate the superior sustainability of green products. In the context of the supply chain, digital transformation has the strongest impact on green production, followed by green materials and consumption (Gholami, 2024). Through blockchain, businesses and stakeholders can easily trace the origin of raw materials, track green logistics, and optimize transportation, which has helped guide businesses to implement green transition not only internally but also throughout the entire value chain. It can be seen that digital transformation not only improves operational efficiency but also provides infrastructure and solutions for businesses to achieve sustainable development goals in green transition.

On the contrary, green transition is not only an independent goal but also plays the role of a driving force and orientation for digital transformation. If digital transformation is a tool, green transition is a strategic goal of the enterprise. These two processes do not go hand in hand but resonate, support, and complement each other. The mutual impact of transformation can be analyzed in the following aspects:First, green transition sets goals and standards that help orient the digitalization process in a more responsible and sustainable direction. Current legal regulations and ESG standards are considered the "green institutional framework" that guides the digital transformation of enterprises. Regulations on sustainability reporting according to GRI standards, or requirements for ESG information disclosure according to IFRS S1 and S2 standards, force enterprises to apply digital systems to collect, process, and report environmental and social data accurately, transparently, and promptly. Mechanisms such as the EU's Carbon Border Adjustment Mechanism (CBAM) or domestic carbon tax laws force businesses to deploy digital technology (IoT, blockchain, Big Data, AI) to monitor emissions, manage supply chains, and ensure carbon traceability. In the second aspect, green transition through the requirement to develop circular business models has become an important guiding factor for business digital transformation. Realizing circular principles such as extending product life cycles, reusing, recycling, and reducing waste all require strong support from digital technology. Digital platforms such as blockchain, IoT, and big data will help businesses track product life cycles, trace raw materials, and manage material flows in the circular value chain. Moreover, models such as product-as-a-service or sharing platforms, which are core models of the circular economy, can only operate effectively on a digital platform (Colombo et al., 2021). In the field of energy management, green transition has created pressure and at the same time directed businesses to deploy digital solutions to achieve the goal of efficient resource use and carbon emission reduction. Smart energy management systems based on IoT, big data analytics, and artificial intelligence allow real-time monitoring of energy consumption, thereby making decisions to optimize operations (Lee et al., 2014). In addition, the transformation in awareness, changing habits, and green consumption behavior has also become one of the important factors guiding businesses to conduct digital transformation. Consumers increasingly demand products with transparent origins and environmental friendliness, which forces businesses to deploy digital technologies such as blockchain, IoT, and data traceability platforms to demonstrate the sustainability of the value chain (Kouhizadeh et al., 2021).

The above analysis reflects the fact that technology and environmental trends are no longer separate but are converging to address global development challenges. Digital transformation and green transition do not only refer to two transformation trends; the integration of these two trends can accelerate the necessary transformations, which is the key to helping businesses improve their long-term competitiveness, adapt to green and sustainable economic models, and bring society closer to the desired level of transformation.

3. THE REALITY OF IMPLEMENTING DIGITAL TRANSFORMATION AND GREEN TRANSITION IN VIETNAM

3.1. Orientation and policy

In recent years, Vietnam has issued many policies and macro orientations to promote digital transformation and green transition as two strategic pillars for sustainable development. Regarding digital transformation, the National Digital Transformation Program to 2025, with a vision to 2030 (Decision 749/QD-TTg, 2020), aims to build a digital government, digital economy, and digital society, thereby forming a national digital infrastructure and data as a foundation for innovation. In parallel, Resolution 57-NQ/TW (2024) of the Politburo identifies science, technology, innovation, and digital transformation as the top important breakthroughs to enhance national competitiveness. Regarding green growth, the Government has issued the National Strategy on Green Growth for the 2021–2030 period, with a vision to 2050 (Decision 1658/QD-TTg, 2021), emphasizing economic restructuring towards low emissions, encouraging the use of renewable energy, and developing a circular economic model and smart infrastructure. In addition, international cooperation programs, such as the macroeconomic reform and green growth program for the 2023–2026 period with the support of GIZ (Germany), are also being implemented to improve the effectiveness of green finance policies and public-private resource management. It can be seen that the Vietnamese State is shaping an institutional framework linking digital transformation and green transition, considering this an inevitable trend to both catch up with the 4.0 Industrial Revolution and meet international commitments on greenhouse gas emission reduction

and sustainable development.

3.2. Results of digital and green transition in various Vietnamese businesses.

Among the group of large industrial enterprises in Vietnam, the process of implementing digital transformation and green transition has made remarkable progress, associated with long-term development strategies and commitments to international integration, especially in large corporations. Below is a summary of the results of implementing digital transformation and green transition at 3 typical enterprises in Vietnam, including Vietnam Dairy Products Joint Stock Company Vinamilk (VNM), Hoa Phat Group Joint Stock Company (HPG), and Vinfast Trading and Services Company Limited.

3.2.1. Vietnam Dairy Products Joint Stock Company Vinamilk (VNM)

Established in 1976, Vietnam Dairy Products Joint Stock Company Vinamilk has grown and become a leading enterprise in the dairy processing industry, currently occupying 75% of the milk market share in Vietnam. In the period of 2023-2024, Vinamilk has achieved many outstanding results in the process of implementing the digital transformation and green transition strategies, considering these as two strategic pillars to improve operational efficiency and promote sustainable development. Regarding green transition, VNM has announced the Vinamilk Dairy Net Zero 2050 roadmap according to SBTi standards, with the short-term goal of reducing greenhouse gas (GHG) emissions by 15% by 2027 and neutralizing 55% of them by 2035. The company has three units (two factories and one farm) certified as carbon neutral according to PAS 2060:2014 standards, of which the Vietnam Beverage Factory neutralized 3.410 tons of CO_2 in 2024, using more than 92% of green energy and reducing emissions by 30% compared to 2022. All factories and farms have GHG emissions inventories according to ISO 14064. VNM has an energy management system called ISO 50001 in all its factories and is increasing its use of renewable energy, generating over 23 million kWh from solar power, 33 million kWh from biomass electricity, and using CNG gas instead of DO/FO oil. The automated smart warehouse at the Vietnam Dairy Factory helps save 70% of energy. The company also develops a circular economy through a biogas system at 100% of farms, recycles solid manure into organic fertilizer, and uses biogas for production. Environmentally friendly packaging is strongly implemented, with the initiative to eliminate plastic straws, use Tetra Top, collect and recycle 4,2 tons of milk cartons, and apply Flexo printing technology with water-based ink. VNM also implemented the Net Zero Forest project in Mui Ca Mau National Park, expected to absorb 17.000–20.000 tons of CO_2, demonstrating its commitment to nature conservation. For digital transformation, VNM has created a system to manage ESG data across 49 locations, tracking 173 types of data that follow GRI, CDP, CSI, and VNSI standards, which helps in managing and alerting in real-time The company applies AI in human resource management, deploys Microsoft Copilot 365, and tests AI in smart waste classification. In the field of operations, VNM operates four smart warehouses with a total capacity of more than 49.000 pallets, using automatic LGV robots to reduce emissions of 1.898 tons of CO_2/year and save energy by up to 70%. The MES system is applied to manage the production process comprehensively, improve productivity, and reduce errors. Regarding human resource management, the myVNMHRM system is deployed to evaluate the capacity and performance of 100% of employees. Smart farms 4.0 apply precision feeding technology, cow health monitoring software, and livestock environment management. In addition, VNM also promotes office digitalization with electronic invoices, digital signatures, and online working platforms to reduce paperwork and operating costs. It can be seen that Vinamilk has become a model in the Vietnamese food and beverage industry by successfully integrating digital transformation and green transition. This combination not only helps the company reduce emissions and improve operational efficiency but also affirms its commitment to sustainable development, meeting international ESG standards and increasing competitiveness in the global market.

Table 1. Vinamilk's digital transformation and green transition results (2023–2024)

Area	Activity/Strategy	Figures/Indicators	Notes/Implications
Green transition	Net Zero Roadmap (SBTi)	- Reduce GHG emissions by 15% by 2027 - Neutralize 55% by 2035 - Net Zero by 2050	Long-term commitment aligned with international standards
	Carbon neutrality	- 3 units certified PAS 2060:2014 (2 factories, 1 farm) - Beverage Plant: neutralized 3.410 tons CO_2 (2024), > 92% green energy, 30% reduction vs. 2022	Demonstrated ability to deliver on green goals
	Emission inventory	100% factories & farms certified under ISO 14064	Ensures transparency and compliance
	Energy management	ISO 50001 at 100% factories	Improved operational efficiency
	Renewable energy	- 23 million kWh solar - 33 million kWh biomass - CNG replacing DO/FO	Cost-saving, emission reduction

	Smart warehouse	70% energy saving at Vietnam Dairy Factory	Optimized production efficiency
	Circular economy	- Biogas at 100% farms - Solid manure recycled into organic fertilizer - Biogas used for production	Waste reduction, resource recovery
	Green packaging	- Removed plastic straws - 4,2 tons of cartons collected & recycled - Flexo printing with water-based ink	Reduced plastic, eco-friendly packaging
	Nature conservation	Net Zero Forest in Ca Mau: absorb 17.000–20.000 tons CO_2	ESG commitment with community engagement
Digital Transformation	ESG data management	- ESG data integration at 49 sites - 173 data types (GRI, CDP, CSI, VNSI) - Real-time alerts	Improved transparency, compliance
	AI applications	- AI in HR - Microsoft Copilot 365 - AI for smart waste sorting	Increased productivity, smart management
	Smart warehouse & robots	- 4 smart warehouses (> 49.000 pallets) - LGV robots reduced 1.898 tons CO_2e/year, saved 70% energy	Optimized logistics, reduced emissions
	MES production system	Comprehensive production process management	Higher productivity, fewer errors
	Digital HR management	myVNMHRM for 100% employees	Transparent, scientific HR evaluation
	Smart farms 4.0	Precision feeding, herd health monitoring software, environment control	Increased productivity, animal welfare
	Paperless office	E-invoices, e-signatures, online work platforms	Reduced paperwork, cost savings

Source: Compiled from the 2024 Sustainable Development Report

Table 2. Environmental parameters of Vinamilk 2022-2024

Criteria	Unit	2022	2023	2024
Energy				
Electricity purchased from EVN	kWh	187,298,535	194,184,416	197,743,510
Solar power used	kWh	15,471,029	22,021,983	23,158,792
Biomass power used	kWh	N/A	27,313,706	33,208,231
Total electricity	kWh	202,769,565	243,520,105	254,110,534
Total energy	MJ	729,970,433	876,830,180	914,962,585
% solar power	%	7.6%	9%	9%
% solar power and biomass power	%	7.6%	20%	22%
Biomass	tons of steam	235,846	232,376	253,718
CNG	mm BTU	217,962	200,385	211,278
DO oil	liters	6,072,926	7,732,637	7,835,325
FO oil	liters	1,419,383	1,380,394	1,268,037
Gas	kg	244,022	255,303	203,278
Gasoline	liters	179,782	472,320	442,255
Coal	kg	N/A	582,429	293,175
Total energy consumption	MJ	2,163,324,010	2,288,287,687	2,401,191,586
Total energy consumption of Vinamilk	MJ	2,163,324,010	2,177,303,932	2,387,796,362
Waste				
Total waste reused, recycled or recovered by other methods	kg	8,839,282	7,959,466	8,019,430
Total waste treated by incineration, landfill and other disposal methods	kg	1,799,645	1,883,393	2,168,812
Water				

Total water input	m^3	7,128,764	7,903,116	8,161,290
Reused water	m^3	216,872	125,108	167,837
Total wastewater output	m^3	3,396,444	3,772,728	4,039,059
Total water consumption	m^3	3,732,321	4,130,388	4,122,231
Carbon emission (CO2)				
Scope 1	kg CO_2e	130,913,160	145,040,596	120,381,773
Scope 2	kg CO_2e	135,248,272	132,689,418	131,793,601
Total Scope 1 and 2	kg CO_2e	266,161,432	277,730,014	252,175,374
Total Scope 1 and 2 from Vinamilk	kg CO_2e	130,913,160	271,870,812	249,289,189

Source: Extract from the VNM's 2024 sustainable development report.

Overall, as a result of implementing green digital transformation, Vinamilk has made significant progress in increasing the proportion of renewable energy and reducing total CO_2 emissions, but challenges remain in water reuse and waste management, especially hazardous waste. This indicates that the business is on the right track in its sustainable development strategy but needs to strengthen more comprehensive circular solutions and environmental efficiency.

3.2.2. Hoa Phat Group Joint Stock Company (HPG)

Hoa Phat is the leading industrial manufacturing group in Vietnam. Starting from a company specializing in trading construction machinery since August 1992, Hoa Phat has gradually expanded into other fields such as furniture, steel pipes, construction steel, refrigeration, real estate, and agriculture. On November 15, 2007, Hoa Phat officially listed its shares on the Vietnam stock market with the stock code HPG. Currently, the Group operates in 05 fields:Iron and steel (construction steel, hot-rolled steel) steel products (including steel pipes, galvanized steel, wire-drawn steel, prestressed steel) - Agriculture - Real estate - Household appliances. Steel production is the core field, accounting for 90% of the group's revenue and profit. In 2024, Hoa Phat Group achieved many important results in both the green transition and digital transformation pillars, clearly demonstrating the orientation toward sustainable development associated with technological innovation. Regarding green transition, Hoa Phat has completed greenhouse gas (GHG) inventory for all 18 units of five corporations and has been certified by BSI (UK) to comply with ISO 14064-1:2018 and ISO 14067:2018 standards. The achievement is an important step in preparation for compliance with the EU's Carbon Border Adjustment Mechanism (CBAM) from 2026. In addition, the group has improved its energy self-sufficiency through a system of thermal power plants utilizing waste heat and waste gas in Hai Duong and Dung Quat, producing a total of 3,18 billion kWh of electricity, meeting over 90% of the electricity demand for steel production, while helping to save VND5.400 billion and significantly reduce CO_2 emissions. Hoa Phat has also implemented many technical innovation initiatives, saving tens of billions of VND each year; for example, optimizing fuel consumption, improving equipment operation, utilizing bottom water in production, and improving burner operation processes to reduce 23,8% of oil consumption. In the field of green products, Hoa Phat develops household product lines using energy-saving and environmentally friendly technology, such as water purifiers using R600a gas, electrostatic powder coating lines that reduce 90% of sludge waste, or freezers made of rust-proof ZAM steel, helping to prolong product life and minimize waste. Regarding digital transformation, Hoa Phat has been strongly deployed at both the group and member company levels. At the group level, digital management systems such as Human Resource Management (HRM), Electronic Office (E-Office), and Shared Data Management (MDM) have been put into operation, standardizing management processes, synchronizing data, and improving decision-making efficiency. Hoa Phat Dung Quat pioneered the application of the SAP S/4HANA system in accounting, purchasing, production, and quality management and deployed Salesforce CRM to optimize sales processes and port management software. In the refrigeration sector, the Hung Yen factory applied the LEAN model, increasing refrigerator productivity by 71% and meeting export standards to the US. In the agricultural sector, member companies applied Bravo software to manage pig and barn sales and added specialized modules for human resource and animal feed management. In addition, Hoa Phat also promoted IT training, cooperating with partners such as AWS to improve digital skills for employees. It can be seen that Hoa Phat has integrated green transition through emission management, energy saving, and developing environmentally friendly products, while promoting digital transformation by digitizing management, production, and supply chain. This combination not only helps the group improve operational efficiency and reduce costs but also prepares it for long-term competitiveness in the context of globalization and increasingly stringent ESG requirements.

Table 3. Hoa Phat group's digital transformation and green transition results (2024)

Area	Activity/Strategy	Figures/Indicators	Notes/Implications
Green transition	GHG inventory & certification	- Completed GHG inventory for 18 units/5 corporations. - Certified ISO 14064-1:2018 & ISO 14067:2018 by BSI (UK)	Prepared for EU CBAM compliance from 2026
	Energy self-sufficiency	- Waste heat & gas power plants in Hai Duong & Dung Quat - Produced 3,18 billion kWh (meeting > 90% steel demand) - Saved VND 5.400 billion	Reduced CO_2, lowered costs, less dependent on grid
	Technical improvements	- Reduced 23,8% oil consumption via burner optimization - Reused blowdown water - Fuel optimization & equipment efficiency - Saved tens of billions VND/year	Higher efficiency, lower costs & emissions
	Green products	- Water purifiers using R600a gas - Powder coating line: reduced 90% sludge - ZAM steel freezers: rust-resistant, longer lifespan	Sustainable consumer products
Digital Transformation	Group-level management	- HRM, E-Office, MDM systems implemented group-wide	Standardized processes, centralized data
	Hoa Phat Dung Quat	- SAP S/4HANA: accounting, procurement, production, quality - Salesforce CRM: sales optimization - Port management software	Modernized management, efficient operations
	Refrigeration production	- LEAN model at Hung Yen factory - Productivity increased 71% for refrigerators - Met US export standards	Enhanced efficiency, export readiness
	Agriculture	- Bravo software for pig sales & farm management - HRM & feed management modules	Transparent and centralized farm management
	Digital skills	- IT training programs - Partnerships with AWS	Stronger digital workforce capabilities

Source: Compiled from HPG's 2024 annual report

Table 4. Environmental results of HPG 2024

Criteria	Unit	2024
Electricity self-generated from residual heat & gas	kWh	3,180,000,000
Rate of meeting production electricity demand	%	>90%
Savings value from self-generated electricity	Billion VND	5,400
Reuse of blowdown water	N/A	Applied
Reduction in oil consumption (technical improvement)	%	23.8%
Reduction of sludge from powder coating line	%	Reduced 90%
CO_2 emissions per ton of steel (reduced by BPRT, dry coke quenching, continuous casting & rolling)	N/A	Reduced compared to before

Source: Compiled from HPG's 2024 annual report

Analysis of the 2024 annual report shows that Hoa Phat has achieved remarkable results in managing and minimizing environmental impacts, although the level of data transparency is still limited compared to pioneering enterprises in ESG disclosure. Overall, Hoa Phat has demonstrated the right direction in combining energy autonomy, technological innovation, and production process optimization to reduce environmental impacts. However, to improve its competitive position and meet the expectations of the international market, the group needs to further promote the standardization and transparent disclosure of environmental data according to international standards, thereby affirming its commitment to sustainable development in the context of global integration.

3.2.3. Vinfast Trading and Services Company Limited.

VinFast is a member company of Vingroup, one of the largest multi-industry private economic groups in Asia. VinFast's vision is to become a smart electric vehicle brand that strongly promotes the global electric vehicle revolution.

Officially listed on the Nasdaq Global Select Market on August 15, 2023, VinFast has quickly established a global presence, attracting the best talents from around the world and collaborating with some of the most iconic brands in the automotive industry. In 2024, VinFast has affirmed its pioneering role in the Vietnamese automobile industry through a strategy of combining green transition and digital transformation, with many outstanding achievements in both domestic and international markets. Regarding green transition, VinFast officially became the leading electric car brand in Vietnam, with nearly 88.000 vehicles delivered domestically and a total of 97.400 electric vehicles globally in 2024. The VF3 and VF5 models became the best-selling cars in the domestic market. Notably, the VF3 mini car model set a sales record when it reached more than 27.000 orders in just 66 hours of opening for sale. VinFast also completed its product range with seven electric car models spanning segments, from mini cars to large SUVs. Internationally, the company has expanded its operations to India, Indonesia, the Philippines, and the Middle East and officially delivered 9.500 vehicles in foreign markets. CKD factories in India and Indonesia were started in 2024 and are expected to be operational from 2025 to optimize investment costs and expand the market. VinFast has also strongly developed a green mobility ecosystem: deploying more than 150.000 charging points domestically and globally (in conjunction with partners), expanding VinBus services to serve 106 million passengers, and helping to reduce more than 48.200 tons of CO_2, equivalent to 2,2 million urban trees. These efforts have been recognized by many international awards, such as being included in the TIME100 Most Influential Companies of 2024 and the VF 8 model winning six awards at the ASEAN NCAP Grand Prix Awards. In terms of digital transformation, VinFast has leveraged modern technology to optimize production and improve customer experience. The factory in Hai Phong has achieved a very high level of automation (90% in the welding shop, 95% in the paint shop) thanks to 1.400 robots from KUKA, ABB, Siemens, and Durr. The company also invested in autonomous battery technology, considering it a strategic step to master the value chain and enhance competitiveness. On the product, VinFast integrates Gen AI into the VF8 model, developed by VinBigdata, allowing for personalized experiences and increased interaction with users. Strategic technology partnerships with NVIDIA, BlackBerry, Erae AMS, and Vector Informatik GmbH help VinFast access and integrate advanced smart car features. Regarding cybersecurity, VinCSS supports VF6, VF7, VF8, VF9, and eBus models to achieve certification according to the European international standard WP.29 UN R-155/R-156 while researching the application of FIDO and FDO to enhance security. In addition, the after-sales service network has been expanded to 111 facilities nationwide, along with a lifetime battery warranty policy and replacement when the capacity drops below 70%, helping to strengthen customer confidence. Overall, VinFast has successfully implemented green transition by expanding the electric vehicle market, developing a sustainable mobility ecosystem, and reducing emissions, while promoting digital transformation through automation, AI, battery technology, and cybersecurity. This combination not only makes VinFast the leading electric vehicle enterprise in Vietnam but also affirms its position on the global electric vehicle map.

Table 5. Vinfast's digital transformation and green transition results (2024)

Area	Activity/Strategy	Figures/Indicators	Notes/Implications
Green transition	EV sales	- Nearly 88.000 EVs delivered in Vietnam - 97.400 EVs globally - VF3 & VF5: bestsellers in Vietnam - VF3: 27.000 orders/66 hours	Market leader in EVs domestically, global expansion
	Product range	7 EV models (mini cars → large SUVs)	Full segment coverage
	International market	- Expanded to India, Indonesia, Philippines, Middle East - 9.500 EVs delivered overseas (2024) - CKD plants in India & Indonesia (operational 2025)	Cost optimization, global scale-up
	Green ecosystem	- >150.000 charging points worldwide - VinBus: 106 million passengers - Reduced 48.200 tons CO_2 (~2,2M urban trees)	Strong EV ecosystem, measurable CO_2 reduction
	International recognition	- TIME100: Most Influential Companies 2024 - VF8: 6 ASEAN NCAP Grand Prix Awards	Enhanced global brand image
Digital Transformation	Manufacturing automation	- Hai Phong factory: 90% welding, 95% painting automated - 1.400 robots (KUKA, ABB, Siemens, Durr)	High productivity, quality consistency
	Battery technology	Investment in in-house battery R&D and production	Strategic control of EV value chain
	AI & smart products	- Generative AI (VinBigdata) in VF8 - Personalized user experience, improved interaction	Differentiated customer value
	Tech partnerships	Collaborations with NVIDIA, BlackBerry, Erae AMS, Vector Informatik GmbH	Access to cutting-edge smart car technologies
	Cybersecurity	- VinCSS certified VF6, VF7, VF8, V9, eBus under	Enhanced vehicle

		WP.29 UN R-155/R-156 - Research on FIDO & FDO	cybersecurity, EU compliance
	After-sales & service	- 111 service centers nationwide - Lifetime battery warranty, replacement if < 70% capacity	Increased customer trust and loyalty

Source: Compiled from Vingroup's 2024 annual report

Table 6. Environmental results of Vinfast 2022-2024

Criteria	Unit	2022	2023	2024
Energy				
Renewable energy	TJ		764.2	879.7
Non-renewable energy	TJ		N/A	N/A
Waste				
Recycled waste	Tons	20,563	32,422	63,091
Hazardous waste	Tons	1,428	2,237	2,986
General solid waste	Tons	3,269	3,066	4,720
Total waste	Tons	25,260	37,725	70,797
Water				
Reused water	m^3			26,404
Carbon emissions				
Scope 1	tCO_2e		7,785	11,121
Scope 2	tCO_2e		131,215	131,275
Total emissions (Scope 1+2)	tCO_2e		139,000	142,396

Source: Compiled from Vingroup's 2024 annual report

VinFast's environmental performance in parallel with the two transformations has shown positive progress in its sustainable development strategy, especially the increase in renewable energy use, expansion of waste recycling, and initial application of water reuse by VinFast. However, the increase in total emissions and waste volume shows that the company needs to continue to invest heavily in green technology and circular solutions to further reduce environmental impact in the context of expanding production scale.

A comprehensive analysis of the practice of implementing two transformation processes simultaneously in three large industrial enterprises in Vietnam shows that digital transformation is an indispensable tool to realize green transition through process optimization, emission monitoring, and environmental data management. At the same time, green transition also plays an orientation role, forcing the digitalization process to be linked to sustainability goals, thereby ensuring that digital technology development takes place in an environmentally friendly direction and creates long-term value for the enterprise. The above enterprises have become pioneering models, demonstrating a leading role in integrating digitalization and sustainable development goals.

According to data from the Ministry of Planning and Investment, by December 31, 2024, in Vietnam, the number of small and medium-sized enterprises (SMEs) accounts for nearly 98% of the total number of enterprises operating in the economy, but they are still facing many challenges in synchronously implementing both digital transformation and green transition. The main reasons come from limitations in investment capital, access to and mastery of technology, as well as the quality of digital-green human resources. In that context, pressure from the export market and increasingly strict ESG requirements from international partners, along with increased operating costs due to inefficient use of energy and raw materials, have become strong driving forces forcing SMEs to find ways to transform to adapt. Some enterprises in the textile and footwear industry have pioneered the application of energy management software, deployed ERP systems integrating green elements, or used blockchain to trace product origins to meet the European Union's carbon border adjustment mechanism (CBAM). In the wood processing industry, some enterprises have applied CAD/CAM and IoT technology to optimize production processes, reduce raw material waste, and deploy digital supply chain management systems to clarify the legal origin of wood for export. In agriculture and aquaculture, many cooperatives and SMEs have used IoT sensors to monitor the farming environment, combining blockchain in tracing the origin of agricultural and aquatic products and meeting strict standards from the US, EU, and Japanese markets. In the food and beverage industry, some SMEs have deployed ERP systems combined with ISO 14001 quality management standards to reduce energy consumption and replace traditional plastic packaging with biodegradable packaging. The logistics sector has also recorded efforts to apply digital routing systems and AI to optimize

transportation routes and reduce fuel consumption and CO_2 emissions, along with the application of electronic documents to limit the use of paper. In the construction and materials industry, a number of small businesses have tested the BIM model to manage digital projects while applying green materials such as unburnt bricks or recycled concrete. These steps show that although SMEs have not been able to make synchronous and comprehensive investments like large corporations, a trend is forming to gradually shift to a digital-green model. This trend not only helps them maintain competitiveness in the global supply chain but also contributes to affirming the increasingly important role of SMEs in the process of implementing the goal of green growth and sustainable development in Vietnam.

4. CONCLUSION AND RECOMMENDATIONS

This study focuses on analyzing the relationship between digital transformation and green transition in both theory and practice in Vietnam, thereby showing that these two processes do not exist separately but are closely interrelated in the context of dual transformation. Firstly, from a theoretical perspective, analytical frameworks such as TOE (Tornatzky & Fleischer, 1990), institutional theory (DiMaggio & Powell, 1983), resource-based view (Barney, 1991), and dynamic capabilities (Teece, 2007) provide different approaches to explain why and how enterprises simultaneously implement digital and green transition. These theories all show that the integration of digital and green capabilities is not only a response to institutional, technological, and market pressures but also a strategy to reconfigure resources, creating sustainable competitive advantages. Second, from a practical perspective in Vietnam, macro policies such as the National Digital Transformation Program and the Green Growth Strategy have created an important institutional framework to promote dual transformation. At the enterprise level, large corporations such as Vinamilk, Hoa Phat, and VinFast have achieved substantial results: applying digital technology to manage energy, control emissions, develop green products, expand international markets, and enhance ESG transparency. Meanwhile, small and medium-sized enterprises (SMEs), despite limited resources, have also initially deployed digital-green solutions to meet the requirements of export markets and partners in the global supply chain. Third, the study emphasizes that the relationship between digital transformation and green transition is two-way: digital transformation is a tool to promote green efficiency through energy management, supply chain optimization, and data transparency; on the contrary, green transition plays a role in driving digitalization when ESG standards, carbon taxes, and social expectations force businesses to invest more heavily in digital technology. From the above analysis, it can be affirmed that dual transformation is an inevitable path for Vietnamese industrial enterprises to improve their competitiveness, respond to globalization trends, and develop sustainably. However, for dual transformation to spread strongly, there needs to be synchronization from three sides: (i) the government continues to improve the institutional framework and incentive mechanisms, (ii) enterprises proactively invest in digital-green capacity, and (iii) support organizations such as industry associations, research institutes, and universities play a role in connecting knowledge and resources. This study not only contributes to strengthening the theoretical framework on the relationship between digital transformation and green transition but also provides practical evidence from Vietnam, contributing to opening up further research directions on measuring the impact of dual transformation on business performance, competitiveness, and sustainable development of industrial enterprises.

From the research results, some important policy and governance implications can be drawn. On the state side, it is necessary to continue to improve the legal framework and incentive mechanisms to support enterprises in simultaneously implementing digital and green transition. Tools such as carbon tax incentives, green-digital innovation funds, and dual-skill training programs for the workforce should be prioritized. At the same time, synchronizing ESG standards and international reporting standards (GRI, IFRS-S) will help Vietnamese enterprises integrate more deeply into the global value chain. On the business side, it is necessary to view dual transformation not only as a compliance obligation but also as a core strategy to improve operational efficiency, reduce long-term costs, and increase competitive advantage. Enterprises should focus on investing in digital infrastructure, integrating green technology, and building ESG governance capacity to both meet institutional requirements and build brand reputation. On the part of intermediary organizations and industry associations, the role of connecting knowledge, providing financial support, and sharing best practices will be key to spreading dual transformation to both small and medium-sized enterprises.

This study mainly focuses on analyzing the relationship between digital transformation and green transition based on theoretical foundations and practical evidence from a number of large industrial enterprises in Vietnam. However, to better understand the impact of dual transformation, future studies can follow several directions:building a quantitative model to measure the level of interaction between digital and green capabilities, as well as their impact on business performance and competitiveness; (ii) expanding the scope of the survey to small and medium-sized enterprises (SMEs) to understand the barriers and drivers of dual transformation under conditions of limited resources; (iii) comparing different industries (steel, automobile, food and beverage, textiles, etc.) to identify differences in transformation approaches and outcomes; and (iv) studying institutional factors and organizational culture affecting the integration of digital and green transition in the context of emerging economies. These research directions not only contribute to perfecting the theoretical framework but also provide useful empirical evidence for policymaking and corporate governance practices in the era of sustainable development.

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