International Journal of Innovative Research and Scientific Studies, 8(1) 2025, pages: 1639-1653

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Impact of digital transformation on sustainable performance of ICT enterprises in Vietnam

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Abstract

The article explores the impact of digital transformation on enterprises' sustainable performance in all three economic, social, and environmental aspects, as well as the mediating role of innovation in the context of developing countries. The study uses the PLS-SEM model to analyze data collected from surveying 254 enterprises in Vietnam's information and communication technology (ICT) field. The research results show that the direct impact of digital transformation on sustainable performance is positive, though not strong. However, through innovation, the indirect effect is substantial. Thus, the study confirms the mediating role of innovation in bridging the relationship. The study also highlights the role of digital skills and strategy in successfully implementing digital transformation. In contrast, the influence of digital technology and government support in ICT enterprises is limited. The sample of the responding companies is limited to enterprises from the ICT field. In addition, this study has not mentioned several other elements that affect digital transformation. The study offers practical implications for business leaders in prioritizing training employees' digital skills and innovating strategies for organizations to achieve effective digital transformation and sustainable performance. The study suggests that enterprises and governments support digital transformation to develop sustainable businesses. Theoretically, the study contributes to the addition of empirical evidence on the impact of digital transformation through innovation on enterprises' sustainability, thereby opening up future research directions.

Keywords: Digital transformation, ICT enterprises, Innovation, Sustainable performance, Vietnam.

DOI: 10.53894/ijirss.v8i1.4712
Funding: This study received no specific financial support.
History: Received: 31 December 2024/**Revised:** 6 February 2025/**Accepted:** 11 February 2025/**Published:** 14 February 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

In the context of the digital economy, digital transformation has become an inevitable measure for businesses to adapt to market changes and move towards sustainable development [1]. An effective business will not only be concerned with profit growth and increasing market share but also needs to pay attention to environmental and social aspects to achieve sustainable performance. Conventional economic business focuses only on maximizing profits, which can lead to a decline in long-term value when faced with social or environmental risks. Creating long-term value by balancing economic profits, environmental protection, and social benefits helps businesses maintain their position in the market and develop stably in the future [2], attract the support of stakeholders, and meet increasingly stringent environmental and social regulations of governments [3]. Digital transformation towards sustainability goals is fundamental to ensuring the organization's success and improving operational efficiency and competitiveness in the market [4]. Digital transformation positively impacts sustainability performance through various mechanisms, such as increasing digital capabilities, strategic alignment, and adaptability to digital transformation, which are key factors contributing to sustainable performance [5]. Digital transformation can optimize the allocation of internal and external resources and improve the efficiency of production, operations, and management to enhance corporate sustainability [6]. Digital transformation, a proactive sustainability strategy, and innovation positively affect corporate sustainability performance [7].

Many studies have confirmed the direct benefits that digital transformation brings to businesses [8-10]. Digital transformation can trigger changes and innovations in businesses, and innovation is essential to help enterprises maintain competitive advantages and sustainable development [1]. The mediating role of innovation in the relationship between digital transformation and business performance is receiving attention from scholars. Su and Wu [1] emphasized the importance of innovation as an intermediary in the digital transformation process to achieve sustainable development. The study by Wang and Yan [11] also suggested that digital transformation positively impacts firm performance mainly through enhancing exploitative innovation, exploratory innovation, and a balanced approach between innovation and dual innovation, highlighting the mediating role of innovation in this relationship. Lu, et al. [12] investigated the mediating role of sustainability exploitation and exploration innovation in linking digital transformation factors with sustainability performance to achieve better performance. Although there have been some studies related to this topic, this study is still motivated to be conducted for several reasons.

Firstly, most current researchers focus on understanding the impact of digital transformation on business performance through financial indicators or business results [6, 13-18]. Meanwhile, further analysis of the impact of digital transformation on sustainability performance, including aspects of the economy, society, and the environment, is still quite limited. Li and Zhao [19] used data from Chinese listed companies to examine the effect of digital transformation on the ESG performance of enterprises. Although ESG scores are a valuable tool for assessing the sustainability of large enterprises, their application to small and medium-sized enterprises in developing countries is unsuitable due to a lack of resources, access to information, and cultural and economic differences. The study by Lu, et al. [12] also examined the impact of digital transformation on sustainability factors. Still, it did not analyze the specific effect of digital transformation on each economic, environmental, and social aspect separately. This leads to insufficient scientific evidence on how digital transformation can improve economic performance, reduce environmental impact, and enhance corporate social responsibility.

Secondly, digital transformation is costly because it requires significant technology investment and compels businesses to innovate in strategy, processes, and organization. Digital transformation involves a comprehensive redesign of business processes and strategies, integrating technology into all aspects of the organization [20-22]. To implement the aforementioned innovations, businesses must not only bear the costs of investing in technology for digital transformation but also incur expenses related to human resource training and development or costs associated with process and organizational change. Meanwhile, businesses in developing countries face numerous challenges due to a shortage of technology, personnel, and organizational resources [23, 24]. Therefore, even if there is awareness and investment in digital transformation, the question remains whether businesses in developing countries, especially SMEs, can perform better through digital transformation activities. This study, which focuses on the impact of digital transformation on the sustainable performance of businesses in developing countries, will help answer this question.

Third, many current studies are recognizing the mediating role of innovation in the relationship between digital transformation and business performance [1, 11, 12]. However, these studies mainly use research samples from public data of listed companies or rely on the number of patent applications to measure innovation, which leads to limitations in the depth and accuracy of information. Some others are only interested in one side of the story. For example, articles by Al-Ayed, et al. [25] and Sang [26] only address the mediating role of digital innovation in SMEs. Ammar and Tamzini [27]; Jing, et al. [28] and Chen, et al. [29] are merely interested in business model innovation to change strategy and business operations. Thus, a research gap exists regarding the lack of studies considering innovation as a mediator in the relationship between digital transformation and sustainable performance.

Fourth, digital transformation is a complex process shaped by factors such as technology, skilled personnel, and strategy [15, 18]. In developing countries, government support is vital for resource-limited SMEs, driving digital economic growth and aiding industry transitions through subsidies, tax incentives, and ecosystem building [18, 30, 31]. The lack of support is a key factor in the failure of digital transformation projects [32]. However, the long-term impact of such support, especially in developing nations, requires further research.

Based on the identified research gaps, this study raises the following questions:

(1) How do organizational factors and government support impact the digital transformation of businesses?

(2) How does digital transformation impact the sustainable performance of enterprises?

(3) How does digital transformation through innovation impact the sustainable performance of enterprises?

To answer the above research questions, we use the PLS-SEM model to explore the impact of government support alongside digital technology factors, digital transformation strategies, and employees' digital skills on digital transformation activities at enterprises. The study also examines the mediating role of innovation, considering it a bridge that contributes to increasing the effectiveness of digital transformation on businesses' sustainable performance. Finally, the study will consider sustainable performance across three dimensions: economic, environmental, and social.

The research sample was taken from survey data from 254 enterprises in Vietnam's information and communication technology (ICT) field. In developing countries like Vietnam, ICT enterprises are expected to be the leading group in digital transformation due to their advantages in understanding and applying technology quickly and early. Therefore, an in-depth understanding of the implications of digital transformation on the sustainability performance of ICT companies can contribute to the widespread digital transformation across various sectors, thus driving the digital economy and offering valuable lessons for countries with similar conditions.

The paper's structure includes six sections. After the introduction, the study presents the theoretical basis explaining the relationship between digital transformation, innovation, and sustainability performance. Section 3 develops the research hypothesis and model. Sections 4 and 5 present the research methodology and results. Finally, the discussion and conclusion are presented.

2. Theoretical Basic Framework

The study supports the research hypotheses using the Resource-Based View (RBV), dynamic capabilities theory, and the "Triple Bottom Line" sustainability model.

RBV theory was proposed by Wernerfelt [33] and later developed by Barney [34]. Wernerfelt [33]pointed out the relationship between resources and profits in enterprises and contended that “the optimal growth of the firm involves a balance between the exploitation of existing resources and the development of new ones” [33]. Barney developed this view and argued that when companies possess valuable, unique, difficult-to-imitate, and non-substitutable resources, they can establish a sustainable competitive advantage over their rivals by implementing new strategies that other companies cannot easily copy [34]. Besides physical or financial resources, technology, human resources, and organizations are also considered enterprises’ resources [35]. In the context of the digital economy, digital technologies brought about by the Fourth Industrial Revolution “are becoming increasingly critical resources for firms to achieve, maintain, and develop a sustained competitive advantage vis-à-vis their competitors” [36]. To maximize the value of digital technology, employees need to have appropriate digital skills and be able to exploit new technologies effectively [37]. Employees’ information and communication technology skills are valuable resources for successful technology projects [38]. By effectively accumulating and utilizing these resources, businesses can strengthen, expand, or create new capabilities that help them generate new capabilities, enhance sustainable competitive advantages, and establish a solid foundation for implementing successful digital transformation strategies [39].

Teece extended the resource-based theory with the concept of dynamic capabilities, which he regarded as a key factor in maintaining competitive advantage in a dynamic business environment. He defined “dynamic capabilities as the firm’s ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments” [40]. The study also highlighted the critical role of innovation and internal adaptability within firms. In a follow-up study in 2017, Teece continued to discuss and reinforce the argument that businesses need to continuously innovate and reconfigure their strategies to maintain competitive advantage, thereby improving sustainable enterprise performance [41].

Based on the RBV theory, this study considers digital technology, digital skills, and digital transformation strategy as internal business resources. An external resource is government support for enterprises' digital transformation activities. Combining these resources will facilitate effective digital transformation for enterprises while stimulating innovations based on the dynamic capability theory, adapting to changes, creating new values, and achieving sustainable performance.

The "Triple Bottom Line" (TBL) model is a sustainable governance framework developed by John Elkington, according to which sustainability consists of three pillars: economic, social, and environmental, forming three key points (triple bottom line). The economic pillar focuses on assessing the financial health of a business, such as profitability, revenue growth, and cost management. The social dimension refers to the impact of business on people, particularly employees, customers, and communities, especially its contributions to social justice. The environmental aspect assesses how a business's operations affect the planet, including resource use, waste management, and efforts to reduce emissions. Elkington affirmed that a sustainable business must generate profits and contribute to the sustainable development of the community and the environment [42]. This holistic approach balances profits with social justice and ecological sustainability [43], thus achieving sustainable development goals. Therefore, the study uses the TBL model approach to measure the impact of digital transformation on economic performance, social performance, and environmental performance in enterprises.

3. Developing Hypotheses and Research Model

3.1. Digital Transformation and Elements of Digital Transformation in the Enterprise

Recognizing the importance of digital transformation, not all businesses succeed in implementing it. Several recent studies have begun to understand the determinants of successful digital transformation in businesses. Zhang's research identified six critical factors for successful digital transformation in SMEs: digital strategy, government support, digital infrastructure, information technology management capabilities, business partners, and top managers. The study also considers employee skills as the moderating role in the relationship between digital strategy, top management, and digital transformation outcomes [18]. Teng et al. affirmed that "the success of digital transformation requires a combination of three factors: digital technology, digital skills, and digital transformation strategies" [15]. Gurbaxani and Dunkle [44] have pointed

out six aspects of digital transformation at the enterprise level and considered them as factors that help position a successful competitive advantage through digital transformation, including strategic vision, a culture of innovation, know-how and intellectual property assets, digital capabilities, strategic alignment, and technology assets. Duc's findings highlight that the Vietnamese government can effectively promote ICT applications and drive digital transformation in enterprises [45].

In the current context of Vietnam, digital technology is making great strides with platforms and applications, providing businesses with a treasure trove of tools to automate processes, process data, and enhance customer interaction. At the same time, a clear digital transformation strategy, investment in digital skills training for employees, and active support from the government through programs to assist businesses in digital transformation and digital infrastructure construction are all vital in promoting this process. From the above overview studies, the author proposes a hypothesis:

H_{1a}: Digital transformation strategy positively impacts enterprises' digital transformation.

H_{1b}: Digital technology has a positive impact on enterprises' digital transformation.

H_{1c}: Employees' Digital skills positively impact enterprises' digital transformation.

H_{1d}: The government's support positively impacts enterprises' digital transformation.

3.2. Digital Transformation and Sustainable Performance

Dyllick, et al. [46] have defined a business's sustainability as a company's ability to achieve its financial goals while maintaining social and environmental values. The authors affirm that a sustainable business must contribute not only to economic benefits but also to social and environmental benefits throughout its operations Dyllick, et al. [46]. Montiel and Delgado-Ceballos [47] have compiled definitions of corporate sustainability from leading journals and concluded that most corporate sustainability definitions emphasize economic, social, and environmental aspects. In his book "Making Sustainability Work," Epstein guides managers to measure and manage sustainable performance by building a sustainability model that uses social, environmental, and financial aspects as the foundation [48]. From the above studies, sustainable performance is a concept that refers to an enterprise not only achieving business and financial goals but also meeting and maintaining environmental and social standards. It is a holistic approach to ensure that businesses grow long-term and are responsible for the community and the environment.

Science and technology advancements have enabled businesses to achieve sustainability. Digital transformation enhances sustainable business performance by promoting the ability to exploit and explore digital resources, adopting digitalization strategies, and encouraging market-oriented business model innovation [49]. Digital transformation also supports sustainable growth in businesses through improved productivity and process optimization. It helps companies reduce resource waste and improve environmental, economic, and social activities [50]. Digital transformation enhances overall productivity and ESG (environmental-social-governance index) performance, reducing information asymmetry, thus allowing for better allocation of financial resources and increasing economic outcomes [19]. Most studies point to the multifaceted benefits of digital transformation in promoting business sustainability and confirm the importance of integrating digital technologies, driving innovation, and engaging stakeholders to achieve long-term sustainable success. Therefore, the author proposes the second hypothesis, which consists of three components corresponding to three aspects of sustainable performance in enterprises:

H_{2a}: Digital transformation has a positive impact on enterprises' economic performance.

H_{2b}: Digital transformation has a positive impact on enterprises' social performance.

H_{2c}: Digital transformation has a positive impact on enterprises' environmental performance.

3.3. Mediating Role of Innovation

Bican and Brem [51] proposed a framework that includes elements of the digital business model and indicates the relationship between digital transformation and digital innovation. Accordingly, businesses use digital technology to optimize resources, form digital business models, and stimulate the emergence of digital innovations. Digital innovations inevitably lead to organizational changes, paving the way for digital transformation in organizations, which profoundly impacts all aspects of business [38]. Digital transformation is an essential enabler for driving innovation, allowing companies to identify trends and react to changes [12] quickly. Digital transformation also significantly improves business performance, which can stimulate the innovation of businesses [16]. Chen and Kim [52] also suggested that digital transformation can drive corporate innovation and affirmed the value of the mediating role of innovation perception [53]. Surahman's research examined the impact of digital transformation and innovation mediation on digital innovation capacity and SMEs' performance during the COVID-19 period [9].

In addition, some scholars focus on how innovation affects business performance. Kotsiopoulos's research empirically examined the effect of innovation (product, process, organization, and marketing innovation) on Greek manufacturing companies' financial performance, non-financial performance, and market outcomes. The results show the significant contribution of product and process innovation to firm performance Kafetzopoulos, et al. [54]. Larios-Francia and Ferasso [55] argue that "in the context of global change and uncertainty, the innovation capacity of organizations is the key to sustainable development" [55]. The two authors' study explored the relationship between innovation and firm performance of micro, small, and medium-sized enterprises in the garment industry of Peru and Colombia. The study results show that product and process innovation positively affect organizational, economic, commercial, and productive performance Larios-Francia and Ferasso [55].

Robertsone and Lapiņa [56] also conducted a study that affirmed the correlation between digital transformation, open innovation, and sustainability. The results prove that digital transformation promotes sustainability and innovation [56]. The research by Mishra and colleagues assesses the direct impact of digital transformation on the innovation and sustainable

performance of Bangladeshi businesses. The research findings show that digital transformation directly and positively impacts open innovation, sustainable performance, and the competitive advantage of businesses [57].

Despite some existing research on the relationship between digital transformation, innovation, and sustainable performance, as well as innovation and business performance, studies investigating the impact of digital transformation on firms' sustainable performance with a mediating role of innovation are still limited. Hence, this study aims to explore digital transformation's effect on enterprises' sustainable performance, with innovation as a mediator. Therefore, the H3 hypothesis, along with four component hypotheses, is presented below:

H_{3a}: Digital transformation has a positive impact on organizational innovation.

H_{3b}: Innovation plays a mediating role in the impact of digital transformation on economic performance.

H_{3c}: Innovation plays a mediating role in the impact of digital transformation on social performance.

H_{3d}: Innovation plays a mediating role in the impact of digital transformation on environmental performance.

The proposed research model is presented in Figure 1.

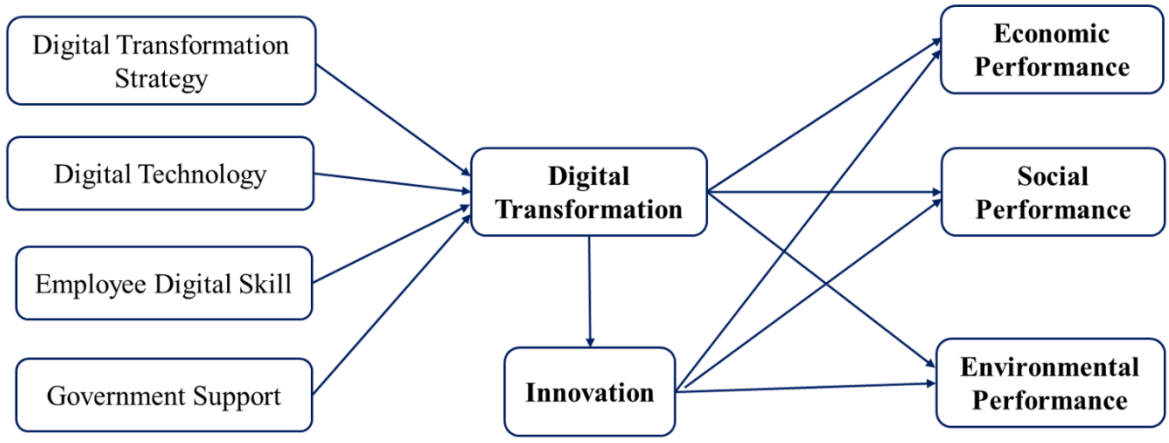

Figure 1.
Proposed research model.

Our research model is inherited and developed from previous studies, especially the work of Teng, et al. [15] and Eikelenboom and de Jong [58]. Specifically, Teng's research investigated the impact of digital technology, employees' digital skills, and digital transformation strategies on enterprises' digital transformation and the impact of digital transformation on financial performance. Based on this model, our research expands by adding the Government Support variable (GOS), which aims to explore the impact of government support on digital transformation. In addition, while Teng, et al. [15] only investigated the impact of digital transformation on financial performance, our research assesses the impact of digital transformation on the sustainable performance of businesses. We evaluate sustainable performance based on the "Triple Bottom Line" theory and use three variables: ECP (economic performance), ENP (environmental performance), and SOP (social performance), according to Eikelenboom and de Jong [58]. However, Eikelenboom and de Jong's research focuses on analyzing the impact of dynamic capabilities on sustainability performance, while our study examines the impact of digital transformation on sustainable performance. Finally, the proposed research model's new point is the inclusion of the Innovation variable (INV), which mediates the relationship between digital transformation and sustainable performance. This differs from studies that only focus on the effect of innovation on financial performance [9, 55, 59, 60] or consider the impact of digital transformation on innovation performance [53, 61].

4. Research Methodology

The study employs quantitative analysis methods using the PLS-SEM linear structural model to clarify the impact of digital transformation and innovation on the sustainable performance of enterprises. The PLS-SEM model was chosen because it is deemed suitable for exploratory research. It enables the study to estimate complex models with multiple structures, indicators, and structural paths without imposing distributional assumptions on the data [62].

The primary data were collected through the survey method, distributed via online questionnaires on Google Forms. The questionnaire consists of three sections. The first section includes basic demographic information about the survey participants. The second section presents some introductory concepts related to digital transformation, innovation, and sustainable performance. The third section uses the 7-level Likert scale to measure the respondents' agreement with their opinions on digital transformation strategies, digital technology, digital skills, digital transformation, organizational innovation, government support, and sustainable performance in their businesses. The indicators of the latent variables are built on previous studies and synthesized in Table 1. Sustainable performance includes three components: economic performance, social performance, and environmental performance.

Table 1.
Variable description in the research model.

Latent variables	Coding	Source
Digital transformation	DTR	Teng, et al. [15], Pousttchi, et al. [63] and AlNuaimi, et al. [64]
Employee digital skill	EDS	Teng, et al. [15]
Digital transformation strategy	DTS	AlNuaimi, et al. [64]
Digital technology	DTE	Pousttchi, et al. [63]
Organizational innovation	ORI	Kafetzopoulos, et al. [60]
Economic performance	ECP	Kafetzopoulos, et al. [60] and Singh, et al. [8]
Social performance	SOP	Eikelenboom and de Jong [58]
Environmental performance	ENP	Eikelenboom and de Jong [58] and Jeble, et al. [65]
Government support	GOS	Rupeika-Apoga, et al. [66]

The research sample was randomly selected from employees and managers at all levels of Vietnamese information and communication technology enterprises (ICT enterprises). Potential respondents were informed about the objectives and content of the questionnaire. They then decided whether to participate in the questionnaire by clicking on the appropriate tab "I agree to participate in the survey" or "I do not agree to participate in the survey" on Google Forms. After agreeing to join the survey, respondents had the right to change their decision to participate at any time by leaving the online questionnaire. A total of 280 responses were collected, of which 254 valid responses were used for research. Sample demographic information is shown in Table 2.

The PLS-SEM model also allows the use of small sample sizes according to the 10 times rule, which states that the smallest sample size should be ten times the highest number of arrowheads directed at any latent variable in the PLS path model [67, 68]. With this structural model, the sample size in this study is 254, which is higher than the minimum sample size and can be considered suitable for data analysis according to PLS-SEM. After the survey data is collected, it is processed and analyzed using SmartPLS 4 software.

Table 2.
Sample description.

	Senior management	**12.90%**
	Middle management	26.40%
	Junior management	6.80%
Job position	Employees	53.90%
	< 5 years	51.97%
	5- 10 years	7.48%
	10- 20 years	27.17%
Years of experience	> 20 years	13.39%
	Male	62.80%
Gender	Female	31.40%
	Private enterprises	56.80%
	State-owned enterprises	38.60%
Firm type	Foreign-owned enterprises	4.60%
	Less than 10	7.90%
	11- 50	20.40%
	51- 100	8.20%
	101- 200	24.60%
Firm scale (People)	201- 300	38.90%

5. Research Results

5.1. Evaluation of Measurement Model

According to Hair, et al. [68], assessing reflective measurement models includes evaluating the internal consistency, convergent validity, and discriminant validity of latent variables. Internal consistency can be assessed through Cronbach's alpha index and composite reliability. The average variance extracted (AVE) is used to evaluate convergent validity. "The

Fornell-Larcker criterion, cross-loading, and especially the heterotrait-monotrait (HTMT) ratio of correlations can be used to examine discriminant validity" [68].

5.1.1. Reliability and Convergence Assessment

Table 3 presents the results of the measurement model assessment through Cronbach's alpha, composite reliability (rho_c), outer loading coefficients, and the average variance extracted (AVE). Researchers believe a good scale should have Cronbach's alpha and composite reliability of 0.7 or higher [69, 70]. The results show satisfactory values for Cronbach's alpha and composite reliability, as the indicators are higher than 0.7.

To assess the convergence validity, the researchers looked at the outer loadings of the indicators and the average variance (AVE). High outer loadings indicate that the observed variables have much in common and can be explained by the latent variables. "A common rule of thumb is that the standardized outer loadings should be 0.708 or higher" [68]. Figures in Table 3 also show that all indicators and structures meet the necessary measurement criteria. Specifically, the outer loadings of the indicators are above 0.78, proving that the measurement model is reliable. In addition, Hair, et al. [68]also suggest that "an AVE value of 0.50 or higher indicates that, on average, the construct explains more than half of the variance of its indicators" in that structure [68]. The AVE values in Table 3 are above 0.50, showing the convergence of the measurement model that has been achieved. In other words, the results show that the measurement model has a good convergence value and internal consistency.

Table 3.
Results of evaluation of internal consistency and convergence validity.

Latent variables	Indicators	Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	AVE
Digital technology (DTE)	DTE1	0.904	0.882	0.886	0.927	0.809
	DTE2	0.873				
	DTE3	0.921				
Digital transformation (DTR)	DTR1	0.869	0.871	0.87	0.912	0.722
	DTR2	0.861				
	DTR3	0.878				
	DTR4	0.787				
Digital transformation strategy (DTS)	DTS1	0.931	0.937	0.937	0.96	0.889
	DTS2	0.958				
	DTS3	0.939				
Employment digital skills (EDS)	EDS1	0.884	0.918	0.918	0.942	0.802
	EDS2	0.921				
	EDS3	0.884				
	EDS4	0.893				
Economic performance (ECP)	ECP1	0.964	0.971	0.971	0.979	0.92
	ECP2	0.96				
	ECP3	0.961				
	ECP4	0.951				
Environmental performance (ENP)	ENP1	0.885	0.898	0.913	0.928	0.765
	ENP2	0.816				
	ENP3	0.919				
	ENP4	0.875				
Social performance (SOP)	SOP1	0.91	0.925	0.935	0.947	0.816
	SOP2	0.846				
	SOP3	0.942				
	SOP4	0.914				
Government supports (GOS)	GOS1	0.909	0.966	0.967	0.973	0.856
	GOS2	0.925				
	GOS3	0.945				
	GOS4	0.934				
	GOS5	0.916				
	GOS6	0.921				
Organization innovation (ORI)	ORI1	0.859	0.941	0.942	0.953	0.772
	ORI2	0.828				
	ORI3	0.857				
	ORI4	0.907				
	ORI5	0.901				
	ORI6	0.919				

5.1.2. Discriminant Validity Assessment

Hair proposed a cross-loading approach, a Fornell-Larcker approach, and a heterotrait-monotrait ratio to assess discriminant validity, or how a construct is genuinely distinct from others. Table 4 presents the loadings and cross-loadings for each indicator. According to this criterion, "an indicator's loading on its assigned construct is higher than all of its cross-loadings with other constructs" [68]. The data in Table 4 show that the loadings of indicators on each construct are all greater than their cross-loadings with others. Hence, discriminant validity is established.

Table 4.
Result of discriminant validity assessment by cross-loading.

	DTE	DTR	DTS	ECP	EDS	ENP	GOS	ORI	SOP
DTE1	0.904	0.591	0.684	0.596	0.632	0.535	0.459	0.641	0.572
DTE2	0.873	0.553	0.63	0.521	0.589	0.596	0.475	0.575	0.52
DTE3	0.921	0.625	0.734	0.585	0.706	0.539	0.473	0.673	0.58
DTR1	0.591	0.869	0.638	0.588	0.625	0.488	0.469	0.63	0.578
DTR2	0.523	0.861	0.626	0.555	0.63	0.479	0.509	0.612	0.575
DTR3	0.539	0.878	0.635	0.549	0.575	0.455	0.513	0.616	0.572
DTR4	0.573	0.787	0.593	0.62	0.683	0.572	0.5	0.618	0.551
DTS1	0.715	0.693	0.931	0.7	0.806	0.601	0.589	0.786	0.685
DTS2	0.702	0.688	0.958	0.706	0.785	0.65	0.631	0.774	0.716
DTS3	0.734	0.694	0.939	0.684	0.75	0.595	0.596	0.791	0.711
ECP1	0.642	0.657	0.743	0.964	0.73	0.671	0.638	0.829	0.705
ECP2	0.582	0.639	0.691	0.96	0.705	0.677	0.634	0.81	0.686
ECP3	0.586	0.649	0.69	0.961	0.698	0.662	0.624	0.804	0.662
ECP4	0.613	0.672	0.71	0.951	0.715	0.688	0.676	0.801	0.711
EDS1	0.611	0.686	0.731	0.654	0.884	0.575	0.55	0.737	0.632
EDS2	0.659	0.658	0.752	0.7	0.921	0.624	0.547	0.729	0.63
EDS3	0.647	0.642	0.723	0.621	0.884	0.574	0.538	0.683	0.557
EDS4	0.648	0.67	0.758	0.684	0.893	0.615	0.591	0.746	0.607
ENP1	0.497	0.522	0.546	0.58	0.564	0.885	0.661	0.586	0.707
ENP2	0.457	0.418	0.417	0.49	0.47	0.816	0.55	0.485	0.518
ENP3	0.564	0.488	0.573	0.662	0.587	0.919	0.709	0.622	0.667
ENP4	0.616	0.603	0.699	0.694	0.678	0.875	0.769	0.712	0.789
GOS1	0.541	0.586	0.626	0.628	0.631	0.74	0.909	0.637	0.698
GOS2	0.468	0.516	0.576	0.604	0.557	0.715	0.925	0.609	0.678
GOS3	0.474	0.556	0.609	0.651	0.586	0.734	0.945	0.633	0.722
GOS4	0.469	0.513	0.576	0.598	0.557	0.712	0.934	0.58	0.676
GOS5	0.484	0.543	0.572	0.627	0.557	0.705	0.916	0.589	0.654
GOS6	0.449	0.534	0.6	0.608	0.556	0.712	0.921	0.618	0.721
ORI1	0.671	0.652	0.729	0.734	0.713	0.57	0.542	0.859	0.674
ORI2	0.639	0.658	0.709	0.676	0.681	0.59	0.512	0.828	0.711
ORI3	0.572	0.602	0.664	0.708	0.66	0.612	0.53	0.857	0.652
ORI4	0.592	0.653	0.77	0.776	0.743	0.633	0.625	0.907	0.721
ORI5	0.594	0.63	0.748	0.777	0.723	0.632	0.623	0.901	0.688
ORI6	0.633	0.656	0.759	0.785	0.744	0.643	0.647	0.919	0.721
SOP1	0.518	0.582	0.636	0.646	0.601	0.718	0.685	0.684	0.91
SOP2	0.448	0.499	0.566	0.581	0.489	0.679	0.678	0.612	0.846
SOP3	0.625	0.653	0.738	0.705	0.681	0.726	0.698	0.782	0.942
SOP4	0.629	0.671	0.737	0.663	0.658	0.696	0.652	0.76	0.914

Table 5.
Result of discriminant validity assessment by Fornell- Larcker criterion.

	DTE	DTR	DTS	ECP	EDS	ENP	GOS	ORI	SOP
DTE	0.899								
DTR	0.657	0.85							
DTS	0.761	0.734	0.943						
ECP	0.632	0.682	0.739	0.959					
EDS	0.716	0.742	0.828	0.743	0.895				
ENP	0.617	0.589	0.653	0.703	0.667	0.874			
GOS	0.521	0.587	0.642	0.67	0.622	0.779	0.925		
ORI	0.702	0.73	0.831	0.846	0.809	0.698	0.661	0.879	
SOP	0.621	0.671	0.747	0.721	0.678	0.779	0.748	0.79	0.904

According to the Fornell-Larcker approach, it is necessary to determine whether the square root of the AVE of each construct is higher than the construct's highest correlation with any other construct in the model [68]. Table 5 shows the outcomes of the Fornell-Larcker criterion evaluation, indicating that the square roots of the AVE for the reflective constructs exceed the correlations between these constructs and other latent variables within the path model, thereby suggesting that all constructs serve as valid indicators of distinct concepts.

In addition, the researchers proposed the evaluation of discrimination using the heterotrait-monotrait ratio (HTMT) index. If the HTMT index of a pair of latent variables is below the threshold of 0.85, the discrimination is well ensured, and the range from 0.85 to 0.9 is the acceptable threshold [68, 71]. The results of the discrimination assessment by the HTMT index are shown in Table 6, where most values are less than 0.85, and none are up to 0.9. Thus, the discriminant validity is ensured.

Table 6.
Results of discrimination assessment according to HTMT criteria.

	DTE	DTR	DTS	ECP	EDS	ENP	GOS	ORI	SOP
DTE									
DTR	0.747								
DTS	0.835	0.812							
ECP	0.681	0.74	0.775						
EDS	0.794	0.827	0.893	0.786					
ENP	0.688	0.654	0.696	0.743	0.724				
GOS	0.564	0.638	0.674	0.691	0.659	0.824			
ORI	0.77	0.806	0.885	0.885	0.87	0.748	0.692		
SOP	0.68	0.741	0.796	0.758	0.729	0.842	0.793	0.842	

5.2. Evaluation of Structural Model

The variance inflation factor (VIF) is used to assess collinearity in the structural model. In the context of PLS-SEM, a VIF value of 5 or higher indicates a potential collinearity problem [68]. Data from Table 7 show that the VIF values of the independent variables (DTR, DTE, and GOS) are less than 3, and both the DTS and EDS variables have values less than 5. This result indicates that there is no collinearity between the variables.

Table 7.
Results of structural model evaluation.

Hypothesis	Paths	VIF	Original sample	Sample mean	Standard deviation	T statistics	f^2	P values	Remark
H1a	DTE -> DTR ^{NS}	**2.516**	**0.153**	**0.156**	**0.091**	**1.688**	**0.024**	**0.091**	**Unsupported**
H1b	DTS -> DTR*	4.178	0.244	0.244	0.094	2.588	0.037	0.01	Supported
H1c	EDS -> DTR***	3.51	0.346	0.343	0.088	3.934	0.089	0	Supported
H1d	GOS -> DTR*	1.781	0.135	0.136	0.061	2.218	0.027	0.027	Supported
H2a	DTR -> ECP*	2.142	0.138	0.137	0.054	2.559	0.032	0.011	Supported
H2b	DTR -> ENP*	2.142	0.169	0.169	0.078	2.171	0.027	0.03	Supported
H2c	DTR -> SOP**	2.142	0.2	0.2	0.065	3.056	0.052	0.002	Supported
H3a	DTR -> ORI***	1.000	0.730	0.730	0.035	20.999	1.142	0.000	Supported
H3b	DTR -> ORI -> ECP***	N/A	0.544	0.545	0.049	11.091	N/A	0	Supported
H3c	DTR -> ORI -> ENP***	N/A	0.42	0.422	0.069	6.102	N/A	0	Supported
H3d	DTR -> ORI -> SOP***	N/A	0.47	0.471	0.051	9.29	N/A	0	Supported

Note: ***Significant at $p < 0.001$ level. **Significant at $p < 0.01$ level**.** *Significant at $p < 0.05$ level**.** NS Not supported at $p > 0.05$ level

Besides, the main criteria for evaluating the structural model in PLS-SEM are the importance of path coefficients, R^2 deterministic coefficients, f^2 effect size, Q^2 predictive relevance, and q^2 effect size [68].

Table 7 shows the result of the direct and indirect relationship between variables. Except for the impact of the digital technology variable (DTE) on the digital transformation variable (DTR) with p-value = 0.091 > 0.05, the remaining relationships are statistically significant due to the p-value < 0.05. The results also show that all impact coefficients are positive, showing that the relationship in the model is all favorable. Mainly, the impact of DTS, EDS, and GOS variables on DTR, as well as the effect of DTR on ECP, ENP, and SOP variables, are relatively small ($0.02< f^2 < 0.15$). However, the impact of DTR on ORI is very significant (f^2 = 1,142), and through ORI, the impact of DTR on ENP, ECP, and SOP variables is moderate and vigorous (f^2 equal 6.102 on ENP, 9.29 on SOP and 11.091 on ECP).

The R^2 determinant measures the model's predictive power and is calculated as the squared correlation between a specific endogenous construct's actual and predicted values. R2 is acceptable with 0.75, 0.50, and 0.25 values, respectively, corresponding to significant, medium, or weak prediction accuracy [72, 73]. Table 8 shows that the R^2 and adjusted R^2 represent the significant prediction accuracy of the model ($R^2 > 0.5$).

Table 8.
Results of predictability assessment.

	R^2	R^2 adjusted	Q^2 predict
DTR	0.616	0.61	0.591
ECP	0.724	0.722	0.561
ENP	0.501	0.497	0.477
SOP	0.644	0.641	0.537
ORI	0.533	0.531	0.66

In addition, the Q^2 value indicates the internal model's predictive relevance [74]. "In the structural model, Q^2 values larger than zero for a specific reflective endogenous latent variable indicate the path model's predictive relevance for a particular dependent construct" [68]. The Q^2 values obtained in Table 8 show that the model's predictive relevance for the dependent structures all reaches values higher than 0.5, demonstrating high prediction accuracy.

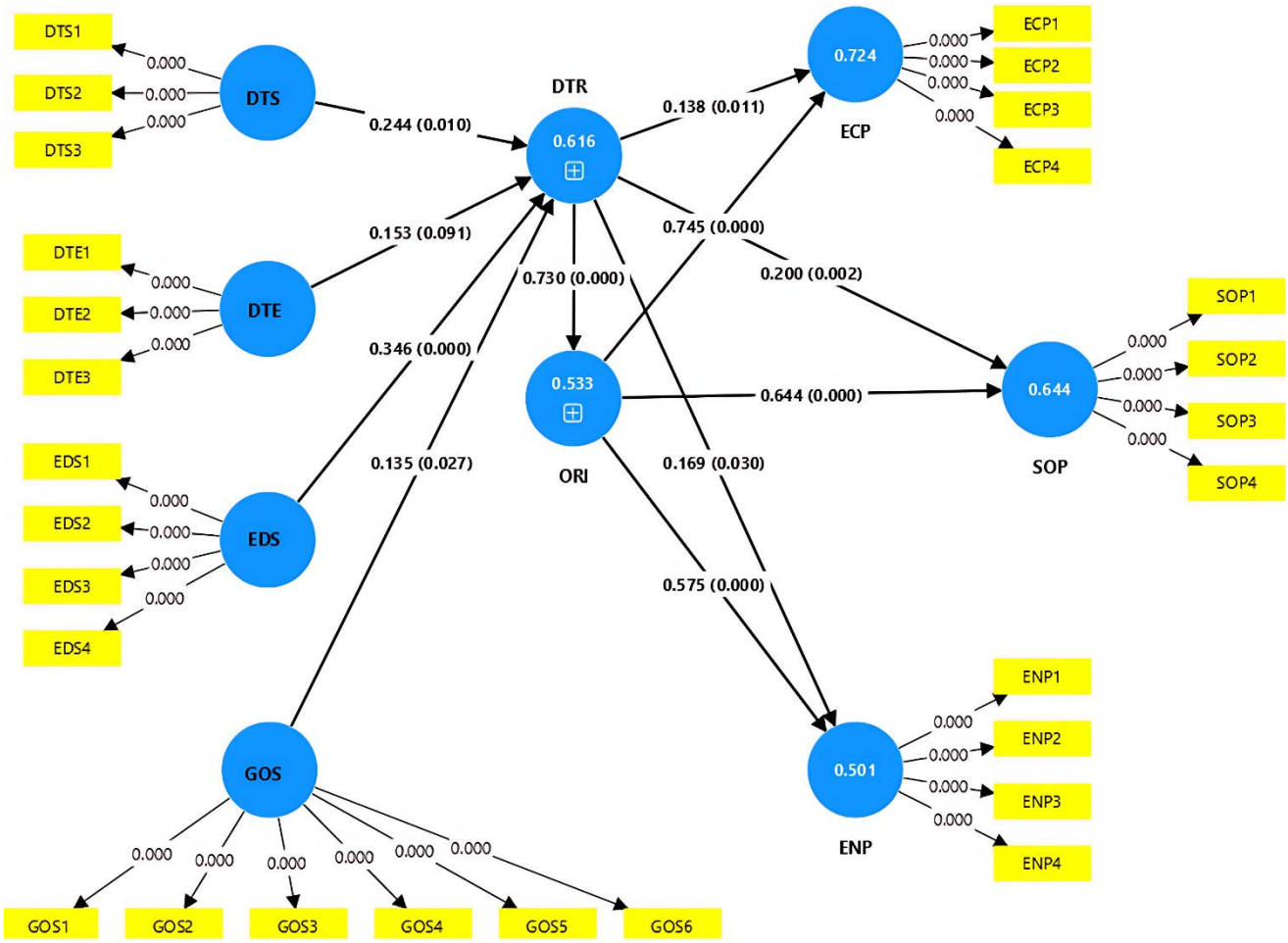

Figure 2.
PLS-SEM structure model.

6. Discussion

This article clarified the relationship between digital transformation and innovation and their impact on the sustainable performance of Vietnamese ICT enterprises. The results show a close relationship between digital transformation and innovation as a premise for the sustainable development of businesses.

First, the study has indicated that digital transformation strategy, digital technology, employees' digital skills, and government support impact the digital transformation of Vietnamese ICT enterprises, and the H1 hypothesis is accepted. This result is also like the results of Teng, et al. [15] and Zhang, et al. [18]. The digital transformation strategy and employees' digital skills have affected digital transformation more strongly than the remaining factors. Due to the characteristics of the information and communication technology field, ICT enterprises are aware of the role of digital transformation in business strategies and plan to use and integrate digital technology quickly into business activities, contributing to the effectiveness of their digital transformation. In addition, employees' digital capacity is also a prerequisite, helping businesses effectively apply digital technology platforms for successful digital transformation. In ICT enterprises, the employees' digital skills are the most decisive influence on digital transformation (path coefficient = 0.346). Thus, this study suggests that businesses with sufficient employees with digital technology skills and regular training to access new technologies will be strong in digital transformation. On the other hand, digital technology and government support have a weaker effect on the digital transformation activities of businesses. This result could be because ICT enterprises are already leading technology enterprises and already have a solid technology foundation to serve their business activities. They are proactive and do not wait for government support to implement digital transformation because digital transformation is an inevitable need of businesses in information and communication technology.

Second, this paper also affirmed the positive relationship between digital transformation and sustainable business performance in all three aspects of economic, social, and environmental performance. So, the H2 hypothesis is also accepted. This result is consistent with the findings of Su and Wu [1], Chen, et al. [49] and Mishra, et al. [57]. However, the influence of digital transformation on economic performance is relatively weak.

Third, although the direct impact of digital transformation on the sustainable performance of ICT enterprises is not very strong, the study has noted that digital transformation strongly influences innovation, and the H3a hypothesis is supported. The H3b, H3c, and H3d hypotheses are also confirmed because innovation, as a mediator, allows digital transformation to have a considerable effect on the corporation's sustainable performance. Digital transformation is the driving force for innovation, which has become the key to sustainable performance. Businesses that know how to apply digital transformation, create innovation in organizational structure, management systems, and operational processes, and explore and apply new ideas will achieve high results in all three aspects of the economy, environment, and society. This idea again asserts that digital transformation is not just about digitization or technological change. Instead, digital transformation is a comprehensive change on an enterprise-wide scale, integrating digital into all business areas to alter the business's operations and generate new value. Since then, the study has emphasized the important role of innovation in the digital transformation process; digital transformation must be accompanied by innovation to create different values, increase competitive advantages, manage costs effectively, reduce environmental pollution, and enhance social activities. By doing this, businesses will increase their chances of achieving sustainable development goals.

7. Conclusion

This study focused on analyzing the impact of digital transformation on the sustainable performance of ICT enterprises, with innovation playing a mediating role. The research findings have contributed to perspectives, both academic and practical.

7.1. Theoretical Contribution

From an academic perspective, the study has partly filled the research gap by exploring innovation's crucial mediating role in the relationship between digital transformation and sustainable business performance. The study affirms that digital transformation stimulates innovation and, through innovation, significantly improves economic results, strengthens social activities, and contributes to environmental protection, creating a strong motivation to promote the sustainable development of businesses. On the other hand, the study also presents that digital technology, digital transformation strategies, employees' digital skills, and government support are prerequisites for digital transformation. In particular, the impact of digital technology and government support on ICT enterprises is relatively weak. At the same time, previous studies highlighted their importance to business digital transformation, especially for SMEs in developing countries [75, 76]. The results thereby orient further research in evaluating the effectiveness of digital technology and government support in the digital transformation of enterprises or expanding the scope of research to enterprises in other fields. Finally, the study has contributed to the addition of empirical evidence and scientific conclusions on the effect of digital transformation through innovation on sustainable performance in SME enterprises in developing countries, providing a reference for future scholars' research.

7.2. Practical Implications

From a practical standpoint, the study also offers several recommendations for businesses and government policymakers. The research findings imply that businesses aiming to conduct digital transformation successfully must begin innovating their strategic vision, changing processes, and organizational structures, and paying special attention to human resources, which are considered the core force in driving successful digital transformation within businesses. In the context of rapid technological changes, enterprises need to strengthen employee training, create conditions to access and cultivate new technological knowledge, improve innovative thinking, and hone digital skills to adapt to changes in the digital age.

SME enterprises will also have a more comprehensive view of the positive impact of digital transformation on the economic, environmental, and social aspects of sustainable business development. In addition, the government should also increase financial and tax support, such as tax breaks for businesses investing in digital transformation, and connect SMEs with banks and financial institutions so that they can access capital to invest in technology. Supporting SMEs in training human resources' digital knowledge and skills will help them quickly carry out digital transformation.

7.3. Limitations and Future Directions

Although the study has provided meaningful contributions in analyzing the impact of digital transformation and innovation on the sustainable performance of ICT enterprises, certain limitations still exist. Firstly, the study uses a survey sample from 254 ICT enterprises of different sizes and geographical regions. While this helps partially to reflect the reality of digital transformation in the industry, the number of samples is insufficient. It may not ensure a complete representation of the entire ICT industry, especially considering the differences in business conditions between regions. Second, the factors considered in digital transformation research may not be exhaustive. Due to data limitations and research time, several other elements that affect digital transformation, such as organizational culture, technology investment, strategic vision, and competitive pressures, have not been mentioned or analyzed comprehensively. Third, the scope of research is limited to businesses in the field of ICT, which are companies that already have investments in digital technology. Therefore, the impact of digital technology on digital transformation in this group of business industries is not statistically significant. Thus, expanding the scope of research to other disciplines can help validate and reinforce the generality of the findings. These limitations open further research directions, including expanding the scale and scope of the research sample, adding other essential elements of digital transformation, and cross-industry comparisons to obtain a more comprehensive view of the process.

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