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-RESEARCH ARTICLE-

DIGITAL ECONOMY STRUCTURING FOR SUSTAINABLE DEVELOPMENT: THE ROLE OF CSR AND GREEN TECHNOLOGY IN IMPROVING GREEN STOCK: EVIDENCE FROM VIETNAM

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—Abstract—

Sustainable Development (SD) has emerged as a global imperative, necessitating focused attention from contemporary researchers and policymakers. In response, this study explores the influence of Corporate Social Responsibility (CSR) and green technology on SD within Vietnam's manufacturing sector. Furthermore, it assesses the mediating function of green stock in the relationship between CSR, green technology, and SD, while also examining the moderating effect of the digital economy (DE) on these relationships. Primary data were gathered from employees through structured surveys, and the interrelationships among the variables were analysed using Smart-PLS. The findings demonstrate that both CSR and green technology exert a positive influence on SD. Additionally, green stock was found to play a significant mediating role between CSR, green technology, and SD. The analysis also revealed that the DE significantly moderates the impact of CSR and green technology on SD within the manufacturing industry in Vietnam. The outcomes offer valuable insights for policymakers, highlighting the importance of enhancing green stock investment, promoting CSR initiatives, and integrating green technologies to effectively pursue sustainable development objectives.

Keywords: Green Stock, CSR, Green Technology, Sustainable Development, Digital Economy.

INTRODUCTION

With the growing awareness of environmental and social issues among the public, it has become essential for business organisations to pursue SD to remain competitive in both domestic and international markets. Achieving SD necessitates that businesses operate in a socially and environmentally responsible manner, aligning their activities with key economic objectives without compromising ecological integrity or societal well-being (Ruggerio, 2021). Enterprises that contribute to sustainable economic growth extend their focus beyond financial gains, taking responsibility for the social and environmental impacts of their operations and ensuring protection for both society and the environment. Such practices foster a business climate conducive to long-term success.

The importance of SD within corporate settings lies in the growing demand for socially

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and environmentally responsible products and services. In competitive marketplaces, consumers increasingly favour companies that demonstrate a commitment to societal welfare and environmental stewardship, as well as compliance with regulatory requirements (Ruggerio, 2021). Multiple factors support the realisation of SD within organisations, including CSR, green technology, and the DE. CSR represents a self-regulatory business model aimed at instilling accountability towards stakeholders and the environment. Through CSR initiatives, companies preserve the quality of essential resources, attract and retain skilled personnel, and enhance their public image, all of which contribute to sustained development (Guo et al., 2020). Green technology involves the application of scientific methods, technological tools, and mechanical systems to protect the environment and develop sustainable products and services. It encompasses areas such as energy efficiency, renewable energy, sustainable transportation, and waste management. The adoption of green technologies addresses environmental concerns among stakeholders and ensures a stable and resource-efficient environment for business, thus enabling SD (Guo et al., 2020). The DE refers to the expansion of economic activities facilitated by the integration of digital technologies that connect individuals, businesses, operations, devices, and data processes. As the DE evolves, it promotes environmental and social awareness, enhances workforce productivity, facilitates access to eco-friendly resources, and fosters long-term sustainable relationships. These aspects collectively contribute to improved environmental performance within firms.

This study investigates SD within Vietnam's manufacturing industry, a vital sector in the nation's economy. In 2004, manufacturing accounted for 10.3% of national employment and contributed 20.2% to the country's Gross Domestic Product (GDP). From 1994 to 2004, the sector's GDP share grew at an average annual rate of 11.3%. Key areas of growth include electronics, food processing, and chemicals. Vietnam benefits from geographical proximity to China and a competitively priced labour force, making it an attractive manufacturing hub in Asia, especially for companies from Korea and Japan. For example, Samsung produces over 40% of its mobile phones in Vietnam. In recent years, the country has also seen rapid expansion in the automobile sector. By 2019, approximately 200,000 individuals were employed in smartphone production for Samsung in Hanoi. Similarly, LG Electronics has shifted mobile phone manufacturing to Vietnam to achieve strategic advantages (Nguyen et al., 2021).

Despite these industrial advances, Vietnam is a socially oriented nation facing several environmental challenges. As a major contributor to national GDP, the manufacturing sector must adopt SD practices that balance economic performance with social and environmental responsibilities. This study responds to that need by focusing on the contribution of CSR and green technology to SD. It also explores the roles of DE and green stock in this context. This research addresses notable gaps in existing literature. First, it jointly investigates CSR—a regulatory business construct—and green technology—a consumption-driven approach—as determinants of SD. Previous studies

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have typically examined these elements in isolation. Second, the study introduces a novel framework wherein DE is analysed as a moderating variable and green stock as a mediating variable in the relationship between CSR, green technology, and SD. Third, unlike earlier research, this study centres on the Vietnamese manufacturing sector to explore the interrelations among DE, CSR, green technology, green stock, and SD.

The paper is structured into five main sections. The second section presents a literature review supporting the formulation of hypotheses. The third outlines the methodology employed, while the fourth details the results. The subsequent section interprets the findings in relation to existing literature. The study concludes with a discussion on practical implications, overall conclusions, and identified limitations.

LITERATURE REVIEW

Human activities, particularly those stemming from economic operations conducted by business organisations, have resulted in numerous environmental challenges and have adversely affected the social welfare of the communities in which these organisations operate. In such circumstances, although businesses may thrive in the short term, they risk undermining their capacity to sustain long-term economic development (Berawi, 2019). Several factors, including CSR strategies, green technology, green stock, and the DE, can contribute to directing organisations towards SD. Prior research has offered varied perspectives on the relationships among CSR strategies, green technology, green stock, DE, and SD. CSR, as a managerial framework, involves businesses undertaking self-regulation to align their operations with broader societal goals, such as enhancing community welfare, protecting the environment, and promoting employee well-being. This approach reflects an awareness of responsibilities towards stakeholders and the natural environment. By fulfilling their social responsibilities and contributing to societal objectives, firms help conserve environmental and social resources for future generations, while also addressing present-day needs. Consequently, such practices support the achievement of SD.

Mishra (2021) conducted an exploratory study employing a case study approach to examine the contribution of CSR to SD. The research focused on 40 Indian companies operating across diverse economic sectors. The study highlights that environmental degradation remains a significant concern in many developing economies and poses a threat to future economic stability. Implementation of CSR initiatives was found to reduce corporate engagement in carbon-intensive activities, meet stakeholder expectations, and thereby facilitate sustainable economic progress. Another study by Mishra (2021) assessed the relationship between CSR and SD, using data from 248 active small and medium-sized enterprises in Romania. The findings suggest that CSR adoption fosters a sense of accountability among both management and employees. This transformation results in socially and environmentally responsible behaviour that conserves natural resources, maintains high-quality human capital, and strengthens

societal support systems, all of which contribute to realising SD. Hence, the study posses the following hypotheses,

H1: *CSR is positively impacted on the SD.*

The utilisation of green technology in areas such as production, processing, transportation, and infrastructure development helps reduce reliance on carbon-intensive energy sources, chemical usage, and waste generation. Additionally, it promotes a healthier workplace for employees, preserves essential natural resources, delivers high-quality goods and services to the public, and supports the sustainability of human capital. These outcomes are critical for ensuring ongoing economic development, thereby contributing to SD. Shan et al. (2021) conducted an empirical investigation exploring the link between green technology, carbon emissions, and SD. Drawing on quantitative data from Turkey spanning 1990 to 2018, their analysis indicates that innovation in green technologies by firms enhances the adoption of energy-efficient systems that prioritise the use of renewable energy sources. This transition reduces carbon emissions, thereby mitigating environmental degradation and advancing SD. Similarly, Hussain et al. (2022) examined the interconnection between green technology, green growth, environmental quality, and SD, focusing on high-GDP countries during the period 2000 to 2020. Their findings suggest that when firms invest in and implement green technologies, economic expansion occurs with minimal environmental harm. This preservation of environmental quality ensures the long-term viability of both natural and human resources. Under such conditions, SD becomes an attainable objective. Thus, the following hypotheses is proposed,

H2: *Green technology has a positive relationship with SD.*

CSR serves as a business framework that outlines the responsibilities expected of organisations as economic actors, while promoting self-regulation to ensure the fulfilment of their societal obligations. Organisations that operate under CSR principles frequently allocate resources to environmentally focused initiatives. The expansion of green stock through such investments enables the economy to adopt eco-friendly operations and fosters conditions conducive to sustained economic growth (Su & Fan, 2022). Lopez et al. (2022) conducted an investigation into the relationship among CSR, green stock, and SD. Their study was based on data collected from 27 publicly listed companies covering the years 2011 to 2019.

Analytical methods included regression analysis, autoregressive modelling, and moving average techniques. The findings suggest that firms embracing CSR tend to integrate environmental and social considerations alongside their pursuit of economic performance. These organisations are more likely to invest in a range of green initiatives such as environmentally responsible data management, green technology, sustainable production processes, waste treatment systems, eco-conscious infrastructure, renewable

energy solutions, reforestation efforts, and related activities. The accumulation of green stock through these actions helps safeguard natural and economic resources for future use, thereby supporting SD. Lopez et al. (2022) also explored the connections among CSR, green stock, green accounting, and SD, focusing on highly polluting firms in Bangladesh. Data were compiled from 212 companies listed on the Dhaka Stock Exchange, covering the period from 2010 to 2019. Their results indicate that implementing CSR shifts managerial focus towards environmental initiatives and stimulates interest in expanding green stock. The growing stock of green assets offers both social and environmental benefits, while also enhancing the sustainability of economic development. Thus, the work proposes the following hypotheses,

H3: *Green stock mediates between CSR and SD.*

When organisations adopt policies that promote the use of green technology—such as renewable energy systems, waste management, recycling and reutilisation processes, sustainable transport solutions, and energy-efficient mechanisms—they often experience a parallel increase in investment towards firms engaged in developing, deploying, or managing these technologies. This rise in green stock contributes to environmental preservation, stabilises climatic patterns, and safeguards ecological productivity. Consequently, firms benefit from improved environmental performance and progress towards SD (Ali et al., 2021). Madaleno et al. (2022) investigated the interconnection between green technology, green finance (as an indicator of green stock), and SD. Their dataset was sourced from the S&P Dow Jones Indices, and the researchers applied three time-varying causality tests to examine these relationships.

The findings suggest that the adoption of green technology stimulates both the consumption of green energy and access to green financing. Firms accumulating green stock demonstrate enhanced environmental stewardship and greater alignment with SD objectives. Thus, green stock is positioned as a mediating factor linking green technology with SD. In a related study, Madaleno et al. (2022) explored the association between green technology (as a proxy for green stock), financial development, and green total factor productivity—a measure of economic sustainability. Data were gathered from 28 provincial regions in China covering the years 2011 to 2021. Their findings confirm that when green technology investment is embedded in corporate strategies, the value of green stock increases, and green-oriented financing activities are stimulated. These developments collectively promote SD. Accordingly, the study proposes the following hypotheses,

H4: *Green stock mediates between green technology and SD.*

Within the DE framework, economic activities evolve through enhanced interconnectivity among individuals, organisations, technological devices, data acquisition, processing, transmission, and digitally managed operations. The integration

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of firms through DE platforms fosters greater awareness of societal responsibilities, market expectations, and emerging strategic approaches. This environment enhances both the capacity and inclination of organisations to adopt CSR-oriented strategies. By implementing CSR practices, businesses can effectively address social challenges and mitigate environmental degradation, thereby advancing towards SD (Melnyk et al., 2019). Chen (2023) examined the link among DE, CSR, low-carbon innovations, and SD, arguing that DE facilitates access to environmentally sustainable energy sources, raw materials, and technologies. The application of such clean resources and energy-efficient methods supports the implementation of CSR, which in turn contributes to reductions in carbon emissions. Through these mechanisms, firms enhance the sustainability of their economic growth. Chen (2023) also explored the interplay among DE, CSR, and SD by analysing data from Chinese enterprises registered between 2011 and 2020. Their findings suggest that DE simplifies the application of CSR strategies, and under such regulatory guidance, firms are more likely to achieve SD. Therefore, the study puts forward the following hypotheses,

H5: *DE moderates between CSR and SD.*

DE encompasses the expansion of digital transactions and connectivity among various stakeholders and sectors through the adoption of advanced technologies. These include the internet, mobile platforms, social media, big data analytics, and information and communication technologies. Enhanced digital connectivity among businesses facilitates the dissemination of knowledge concerning rising environmental issues, fostering a stronger connection with ecological systems. Consequently, firms acquire awareness of green technology and adopt such practices to reduce their ecological impact. This advancement in environmental performance contributes meaningfully to SD (Savchenko & Borodina, 2020). Luo et al. (2023) investigated the association between DE and SD, concluding that the digital transition encourages firms to pursue technological innovation through easier access to and deployment of various technologies. The substitution of conventional operations with green technology results in reduced operational costs, enhanced product and service quality, and responsiveness to environmental expectations of the public, thereby promoting sustainable economic outcomes. Similarly, shahzad et al. (2020) examined the interplay between DE and SD, highlighting that DE fosters organisational integration and facilitates strategic adoption of green technology. This integration not only supports the implementation of environmentally responsible practices but also strengthens the contribution of green technology to achieving SD. Therefore, the study possesses the following hypotheses,

H6: *DE moderates between green technology and SD.*

RESEARCH METHODS

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This study explores the influence of CSR and green technology on SD within Vietnam's manufacturing sector, with a particular focus on assessing the mediating function of green stock in the relationship between CSR, green technology, and SD.

Table 1: Measurement Scale of the Variables

Items	Statements	Sources
Corporate Social Responsibilities		
CSR1	My firm works to protect and improve the environmental quality.	(Shahzad et al., 2020)
CSR2	My organization makes investment in the activities of better life.	
CSR3	My firm works to minimize the environmental issues.	
CSR4	My organization always targets a sustainable growth.	
Green Technology		
GT1	My firm select lower pollution created material.	(Song et al., 2020)
GT2	My firm select the materials that consume lower energy and resources.	
GT3	My organization uses minimum level of materials to make the product.	
GT4	My organization focus on the easy to recycle the products.	
GT5	My company used manufacturing process that effectively reduces the emissions.	
GT6	My company used manufacturing process that recycles waste.	
GT7	My company used manufacturing process that reduces the consumption of oil.	
Green Stock		
GS1	I feel to select the green investment is a sensible idea.	(Osman et al., 2019)
GS2	I believe that green investment improve the performance.	
GS3	I believe that green investment is trustworthy.	
Digital Economy		
DE1	My organization easily accesses data.	(Jun et al., 2022)
DE2	My organization provides seamless connection among partners.	
DE3	My organization can exchange real-time information with our partners.	
DE4	My organization can aggregate information from data bases of our partners.	
Sustainable Development		
SD1	I believe that the usage of more natural resources than our requirement does not threaten the well-being of people.	(Gericke et al., 2019)
SD2	I believe that we should follow the regulations to protect the environment.	
SD3	I believe that we should take measures about the climate change.	
SD4	I believe there is no issue if each one of us consumes water then we want.	

Additionally, it evaluates the moderating effect of DE on these relationships. Data were gathered through a structured survey administered to employees. The constructs were operationalised using multiple items: CSR was measured using four items, green technology with seven, green stock using three, DE with four, and SD also with four items. These measurement scales were adopted from prior research, as detailed in Table 1.

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The study targeted employees from Vietnam's manufacturing sector as its sample population. A purposive sampling technique was employed to ensure that the data were collected specifically from individuals engaged in environmentally responsible practices. Data collection was conducted through a combination of in-person visits to firms and email distribution. Out of the 544 distributed questionnaires, 357 valid responses were obtained, yielding a response rate of approximately 65.63 percent. To analyse the relationships among the study variables, the researchers utilised Smart-PLS, a tool recognised for its efficacy in handling complex model structures (Hair et al., 2020). The conceptual framework included two independent variables, CSR and green technology (GT), with green stock (GS) acting as a mediating variable, DE serving as a moderating factor, and SD representing the dependent construct. These variables are illustrated in Figure 1.

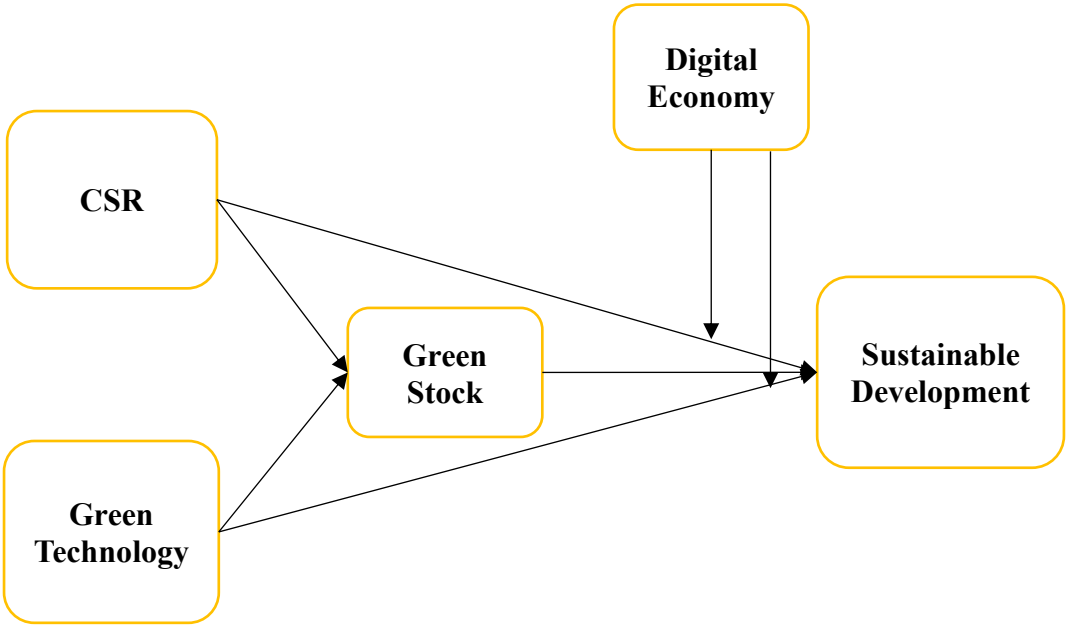

Figure 1: Research Model

RESEARCH FINDINGS

Convergent validity was assessed through composite reliability (CR) and Cronbach's Alpha, both of which reported values exceeding the threshold of 0.70. Additionally, the assessment incorporated average variance extracted (AVE) and factor loadings, where all figures surpassed the benchmark value of 0.50. These results confirmed a strong internal correlation among the measurement items. The detailed values are presented in Table 2.

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Table 2: Convergent Validity

Constructs	Items	Loadings	Alpha	CR	AVE
CSR	CSR1	0.839	0.892	0.925	0.756
	CSR2	0.903			
	CSR3	0.880			
	CSR4	0.855			
Digital Economy	DE1	0.902	0.818	0.882	0.654
	DE2	0.800			
	DE3	0.664			
	DE4	0.850			
Green Stock	GS1	0.858	0.833	0.900	0.749
	GS2	0.875			
	GS3	0.864			
Green Technology	GT1	0.765	0.886	0.911	0.594
	GT2	0.802			
	GT3	0.720			
	GT4	0.820			
	GT5	0.731			
	GT6	0.773			
	GT7	0.779			
Sustainable Development	SD1	0.773	0.794	0.866	0.618
	SD2	0.796			
	SD3	0.792			
	SD4	0.782			

Moreover, discriminant validity was evaluated using the Heterotrait-Monotrait (HTMT) ratio. The results indicated that all values remained below the 0.90 threshold, signifying low inter-construct correlations. The specific values are provided in Table 3.

Table 3: Discriminant Validity

	CSR	DE	GS	GT	SD
CSR					
DE	0.532				
GS	0.612	0.540			
GT	0.641	0.629	0.530		
SD	0.751	0.826	0.721	0.751	

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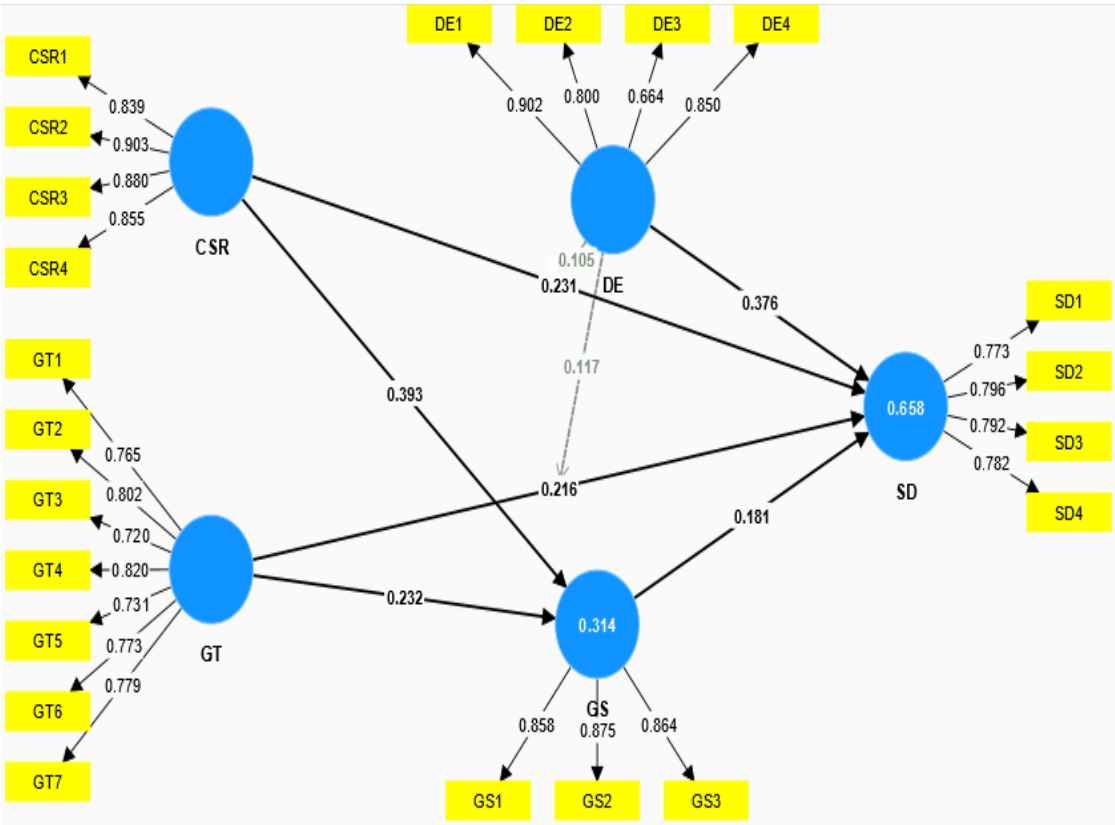

Figure 2: Measurement Assessment Model

The results demonstrated that both CSR and GT are positively linked with SD within Vietnam's manufacturing sector, thereby supporting H1 and H2. Furthermore, the findings confirmed that GS plays a significant mediating role in the relationship between CSR, GT, and SD, leading to the acceptance of H3 and H4. Lastly, the analysis revealed that DE significantly moderates the influence of CSR and GT on SD, supporting H5 and H6. These associations are detailed in Table 4.

Table 4: Path Analysis

Relationships	Beta	Standard Deviation	T Statistics	P Values
CSR -> GS	0.393	0.056	6.975	0.000
CSR -> SD	0.231	0.044	5.210	0.000
DE -> SD	0.376	0.043	8.842	0.000
GS -> SD	0.181	0.041	4.402	0.000
GT -> GS	0.232	0.057	4.075	0.000
GT -> SD	0.216	0.052	4.130	0.000
DE x GT -> SD	0.117	0.049	2.387	0.017
DE x CSR -> SD	0.105	0.042	2.498	0.013
CSR -> GS -> SD	0.071	0.018	3.928	0.000
GT -> GS -> SD	0.042	0.015	2.879	0.004

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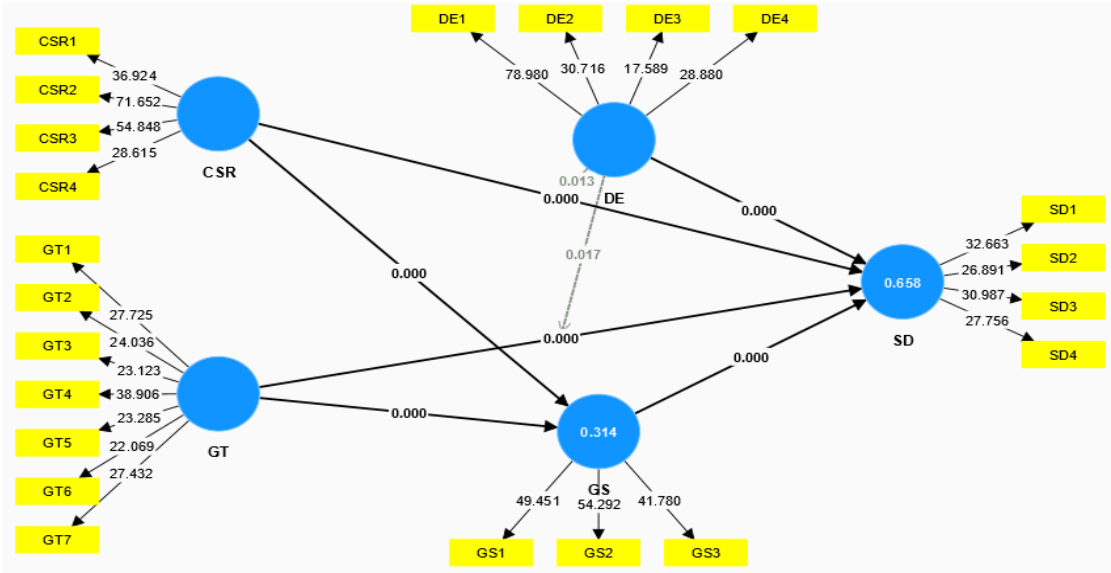

Figure 3: Structural Assessment Model

DISCUSSION

The present research explores the influence of CSR and GT on SD, while also assessing the mediating role of GS between CSR, GT, and SD. Additionally, the study investigates how DE moderates these relationships within Vietnam's manufacturing sector. The findings indicate a significant positive association between CSR and SD. These outcomes align with prior research by (Abad-Segura et al., 2019), which suggests that organisations implementing CSR balance economic, environmental, and social objectives, thereby contributing to ecological conservation and human welfare, ultimately fostering sustainable economic development. Similarly, the results concur with the observations of (Grover et al., 2019), who argue that CSR initiatives enable firms to safeguard various resources and capitalise on opportunities that support SD (See figure 2 and figure 3).

Moreover, the analysis reveals that GT also has a significant positive relationship with SD. These findings are consistent with (Abad-Segura et al., 2019), who assert that adopting GT transforms operational processes in an environmentally responsible manner, thereby reducing pollution and contributing to sustainability goals. This is further supported by Bhutta et al. (2022), who suggest that implementing GT mitigates environmental challenges while enhancing the quality of goods and services, thereby supporting SD. The results further demonstrate that GS plays a vital mediating role between CSR and SD. This is supported by Song et al. (2022)s, who argue that CSR-oriented firms tend to increase investments in environmentally friendly projects, thereby boosting GS, which, in turn, enhances sustainable production practices. These

findings are corroborated by Bhutta et al. (2022), who propose that CSR execution directly fosters the accumulation of GS, thereby facilitating SD.

Additionally, GS is also found to mediate the relationship between Song et al. (2022) emphasise that integrating GT into daily operations raises the value of GS through the development and deployment of sustainable technologies, ultimately improving environmental outcomes and supporting Yang et al. (2022) echo this perspective, indicating that increased utilisation of GT contributes to higher GS and positively impacts sustainability. The analysis also indicates that DE significantly moderates the relationship between CSR and SD. This is affirmed by Song et al. (2022), who note that DE enhances awareness of environmental and societal responsibilities, encouraging firms to adopt CSR strategies. Technological integration under DE enables effective CSR implementation, leading to SD. These insights align with Castro and Lopes (2022), who argue that DE strengthens the role of CSR in supporting sustainability. Lastly, the study finds that DE moderates the link between GT and SD. According to Yang et al. (2022), the transition of firms and individuals toward DE facilitates the adoption of GT, thereby promoting sustainability. Sudoh (2005) similarly observes that the expansion of DE contributes to the widespread use of GT, which supports the attainment of SD.

STUDY IMPLICATIONS

This study holds considerable relevance for emerging economies such as Vietnam, where ongoing economic advancement necessitates sustainable growth practices. The findings offer strategic insights for policymakers seeking to foster SD. Specifically, the research underscores the imperative for business organisations to integrate CSR principles into their operational frameworks, thereby contributing positively to national sustainability objectives. Furthermore, the study emphasises the importance of promoting the adoption of GT across the corporate sector as a means of advancing SD. It also highlights that embedding CSR within organisational policies can stimulate the accumulation of GS at the national level, ultimately supporting sustainable economic trajectories. Additionally, the study advocates for the incorporation of GT into routine business activities, which is expected to enhance the overall value of GS and facilitate the attainment of SD. It further argues that both regulatory bodies and enterprises should actively support and engage in DE. By doing so, the implementation of CSR becomes more feasible, reinforcing sustainable development efforts. Moreover, the research suggests that the widespread integration of DE may increase the adoption rate of GT, thereby accelerating the pace of sustainability within economic development.

CONCLUSION

The objective of this study was to examine the influence of CSR and GT on SD, while also assessing the mediating role of GS and the moderating effect of DE in these relationships. Using a quantitative approach, primary data were gathered through questionnaires from the manufacturing sector in Vietnam. The findings revealed that both CSR and GT positively impact SD. CSR practices contribute to resource preservation, enhance human resource efficiency, improve corporate image, and support quality production, thereby fostering sustainable economic growth. Similarly, the adoption of GT enables environmentally responsible business operations, aligning with stakeholder expectations. The study also found that GS significantly mediates the effect of CSR and GT on SD, while DE positively moderates these relationships, indicating that its expansion strengthens the pathways to achieving SD.

LIMITATIONS

The study has certain limitations that require attention from future researchers. It focuses solely on the roles of DE, CSR, and GT in SD, without considering other relevant factors such as green finance, green human resources, energy efficiency, and sharing efficiency. Future studies should incorporate these dimensions to provide a more comprehensive understanding of sustainable economic development. Additionally, the data were collected only from Vietnam, a developing country with unique environmental and economic characteristics. Subsequent research should expand the scope to include both developing and developed economies for broader generalisability.

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