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## ARTÍCULO

### The Impact of Technological Linkages, Energy Efficiency, and Public-Private Investment on Sustainable Performance: Evidence from SMEs in the Southern Key Economic Zone of Vietnam

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**Abstract:** Sustainable performance has become a crucial factor that can be attained through efficient technological connections and energy conservation. This factor requires the attention of new researchers and policymakers. In light of this, the current study investigates the effect of technical linkages, energy efficiency, and public-private investment on the sustainable performance of SMEs in the Southern Key Economic Zone of Vietnam. In addition, the role of organizational support as a moderator between technological linkages, energy efficiency, and sustainable performance of SMEs in the Southern Key Economic Zone of Vietnam is investigated. Using survey questionnaires, the research collects primary data from the employees of SMEs in the Southern Key Economic Zone of Vietnam. In addition, clever PLS was used to evaluate the dependability and associations of data variables. Results indicated that technological linkages, energy efficiency, and public-private investment have positive relationships with the sustainable performance of SMEs in Vietnam's Southern Key Economic Zone. The results also demonstrated that organizational support moderates' technological linkages, energy efficiency, and sustainable SME performance in Vietnam's Southern Key Economic Zone. The research assists policymakers in Vietnam and developing nations in formulating policies about sustainable performance through effective technological links, energy efficiency, and public-private investment.

## 1. Introduction

Sustainable performance has become a crucial factor that can be attained through efficient technological connections and energy conservation. This factor requires the attention of new researchers and policymakers. In light of this, the current study investigates the effect of technical linkages, energy efficiency, and public-private investment on the sustainable performance of SMEs in the Southern Key Economic Zone of Vietnam. In addition, the role of organizational support as a moderator between technological linkages, energy efficiency, and sustainable performance of SMEs in the Southern Key Economic Zone of Vietnam is investigated. Using survey questionnaires, the research collects primary data from the employees of SMEs in the Southern Key Economic Zone of Vietnam. In addition, clever PLS was used to evaluate the dependability and associations of data variables. Results indicated that technological linkages, energy efficiency, and public-private investment have positive relationships with the sustainable performance of SMEs in Vietnam's Southern Key Economic Zone. The results also demonstrated that organizational support moderates' technological linkages, energy efficiency, and sustainable SME performance in Vietnam's Southern Key Economic Zone. The research assists policymakers in Vietnam and developing nations in formulating policies about sustainable performance through effective technological links, energy efficiency, and public-private investment.

## 2. Literature Review

Sustainability is a comprehensive concept that reduces a company's negative impact on society and the environment while ensuring economic growth. Population and economic growth are proportional to increased emissions and resource consumption, causing an environmental crisis (Chien et al., 2020). Due to environmental and social consequences, stakeholder pressure on organizations to respond to this crisis and address ecological and social degradation issues and climate vulnerability has increased (Braam & Peeters, 2018; Chien et al., 2021). External bodies also pressure businesses to become more sustainable while managing competition from technological innovation and globalization. These external pressures from NGOs, the government, or policy-making bodies will generate internal motivation and encouragement to incorporate sustainable and environmentally friendly practices to improve sustainable performance. Manage the SME's sustainable performance. Diverse factors play an essential role.

Technological linkages, also known as specialized networks or collaborations, facilitate the transfer of technology, expertise, and knowledge between various organizations, thereby enhancing the technological capabilities of small and medium-sized enterprises (SMEs). In addition to providing access to innovative practices that improve the firm's performance, technological links also provide access to such practices. Additionally, technological connections support research and development activities and innovation, which are crucial for developing sustainable solutions. In addition, these collaborations foster partnerships between diverse organizations, enabling them to use innovative technologies to create sustainable and environmentally friendly products, services, and processes. Borah et al. (2022) and Nawaz et al. (2020) found that technological linkages enable businesses to implement technologies that mitigate environmental impact and maximize resource efficiency. These technologies are associated with waste management, emission reduction, water conservation, optimizing business operations, and enhancing sustainability performance. Because of technological advancements, customers, stakeholders, and investors can obtain services or products with unique and innovative characteristics. Social responsibility allows firms to innovate to

gain a competitive advantage in the market (Fernando et al., 2019; Hanif et al., 2022). However, small and medium-sized enterprises should add technological links to their business operations and strategies to compete in sustainability performance to remain competitive. This dialogue leads to the following conclusion:

**Hypothesis 1:** The technological linkages have a positive impact on the sustainable performance of the firms.

Environmental impact, resource consumption, and economic sustainability are all affected by energy efficiency. Energy efficiency helps small and medium-sized businesses save money through energy-efficient practices and technologies that reduce energy consumption. This allows businesses to optimize financial resources that can be used for other business operations, such as marketing, training, or product development, thereby enhancing their sustainability. By improving their energy efficiency, small and medium-sized enterprises (SMEs) can reduce their carbon footprint and mitigate the effects of climate change. This increases environmental sustainability and helps organizations meet industry standards and regulatory requirements emphasizing environmental performance (M. S. Hussain et al., 2021; S. A. R. Khan et al., 2020). As many investors and consumers are concerned with a company's commitment to sustainability and the energy efficiency process, energy efficiency helps an organization achieve a competitive advantage. Adopting these practices also enhances SMEs' brand image and reputation, increasing trust, customer loyalty, and new business opportunities (Baloch et al., 2021; Sun et al., 2021).

In addition, energy-efficient practices help optimize the utilization of resources, such as basic materials and other resources. When these resources are utilized effectively, they will help small and medium-sized enterprises (SMEs) optimize their production processes and supply chains and reduce waste, resulting in increased productivity, cost savings, and sustainable performance. By emphasizing energy-efficient operations, small and medium-sized enterprises can reduce their carbon footprint and improve their bottom line, thereby enhancing their sustainability performance and contributing to the success of their organizations. This dialogue leads to the following conclusion:

**Hypothesis 2:** Energy efficiency has a positive impact on the sustainable performance of the firms.

Public-private investment aids the company in acquiring funds from diverse sources. Due to perceived risk and limited financial resources, it is difficult for small and medium-sized enterprises to obtain capital to engage in green practices and sustainable initiatives. These investments for small and medium-sized enterprises (SMEs) can provide them with grants, funding, or financing so they can complete their sustainable project. This will assist them in overcoming the obstacles that businesses face when implementing sustainability technologies or strategies. Public-private investment also aids SMEs with capacity building and assistance, such as mentoring, training, and counseling services, so they can adopt sustainability practices that improve their performance. These investments from public or private organizations also facilitate partnerships or collaboration between these sectors and SMEs. This also creates opportunities for small firms to collaborate with larger firms, such as government agencies or research institutions, to better society (Cheng et al., 2021; Chien et al., 2022). In addition to innovation and innovative practices, the collaborations provide these businesses with sustainable performance. This funding motivates small and medium-sized enterprises to prioritize green and environmentally favorable sustainable projects. Many small and medium-sized enterprises (SMEs) operate in various industries that may produce

environmentally harmful goods due to limited resources and financing (Shah et al., 2021; Wojewnik-Filipkowska et al., 2019). This funding will assist them in initiating such an initiative, thereby demonstrating their social responsibility. Public-private investment plays a significant role in enhancing the firm's long-term performance by providing technical assistance, collaboration, or initiatives. This funding and investment would assist in the elimination of obstacles to sustainable practices, thereby contributing to the success of SMBs. This dialogue leads to the following conclusion:

**Hypothesis 3:** The positive impact of public-private investment on the sustainable performance of the firm.

Depending on the facilities provided by the organization, organizational support may either inhibit or enhance the impact of technological links on the firm's sustainability. Technical linkages are the interactions and relationships businesses develop with various technological sources that provide them with technology services. These linkages will provide firms with innovative strategies, knowledge, or technologies to enhance their performance (Saunila et al., 2019). Organizational support includes managerial assistance, financial resources, training or seminars, and a positive work environment. When businesses assist by fostering the integration of technological links into their operations, their success will increase. Firms will be able to invest in infrastructure, technologies, or tools that promote sustainability performance with the assistance of financial resources provided by an organization. To obtain a competitive advantage, upper management must support the implementation of these innovative techniques, tools, and technologies. Management can support, direct, or facilitate implementing and using innovative technologies to increase the firm's sustainability. Employees also require training to improve the knowledge and abilities needed to implement these technologies for sustainable use (Yongan Zhang et al., 2019). Training will also assist employees in understanding how sustainable practices contribute to the success of businesses.

Consequently, organizational support moderates the relationship between sustainability performance and technological links. This indicates that when companies provide SMEs with training, resources, and management support, they improve their sustainability performance. This dialogue leads to the following conclusion:

**Hypothesis 4:** The moderating role of organizational support between technological linkages and sustainable performance of the firm.

Utilizing practices, processes, and technology that optimize or reduce energy consumption while minimizing gas emissions and waste is energy efficiency. These practices will result in the companies' lowest operational expenses, enhanced sustainability, or negligible environmental impact. Organizational support can be through training, research facilities, funding, or other resources that encourage and promote innovative approaches to implementing sustainable practices. Sponsorship from organizations will provide the means to invest in energy-efficient apparatus or technologies, thereby minimizing environmental impact and optimizing resource utilization. In addition, organizations can offer development and training programs that expand knowledge of energy-efficient strategies (Sun et al., 2019). Firms can establish energy-efficient policies and sustainability objectives and provide employees with support and direction regarding these initiatives. This methodology will result in the development of a positive work culture that promotes the empowerment of employees and encourages their creative ideas to improve the sustainability performances of firms. Diverse training programs will also assist in honing various technical skills essential for obtaining a market advantage. In

addition, organizations can provide employees with multiple channels and platforms for learning how to implement energy-efficient techniques and processes. Due to international pressure and customer awareness, businesses, particularly SMEs, must deal with and resolve the sustainability crisis, which contributes to a positive brand image and improves the firms' sustainable performance. This dialogue leads to the following conclusion:

**Hypothesis 5:** The moderating role of organizational support between energy efficiency and sustainable performance of the firm.

### 3. Research Methods

The research examines the effect of technological interdependencies, energy efficiency, and public-private investment on sustainable performance. In addition, the role of organizational support as a moderator between technological linkages, energy efficiency, and sustainable implementation of SMEs in Vietnam's Southern Key Economic Zone is investigated. Using survey questionnaires, the research collects primary data from the employees of SMEs in the Southern Key Economic Zone of Vietnam. These questionnaires are derived from prior research. The five questions about technological linkages were taken from Lazar et al. (2020), the three questions about energy efficiency were extracted from Park and Ohm (2014), the three questions about public-private investment were taken from Xie et al. (2022), the six questions about organizational support were adopted from Islam and Ahmed (2018), and the seven questions about sustainable performance were taken from Shetty et al. (2001). The following questions are listed in Table 1.

The surveys were used to collect the information. In addition, as respondents, the researchers chose SME employees. The surveys were disseminated to employees via in-person visits, emails, and postal mail. The personnel were selected using a simple random sample. The researchers distributed approximately 547 questionnaires, but only 301 valid responses were received, representing a response rate of roughly 55.03 percent. In addition, the researchers utilized clever PLS to evaluate the dependability and associations of data variables. This effective statistical tool yields the finest results even when complex frameworks or large data sets are utilized by researchers (Hair et al., 2017). Three independent variables, including technological linkages (THL), energy efficiency (EEF), and public-private investment (PPI), were also utilized by the researchers. In addition, the researchers employed a predictor named sustainable performance (SPR) and a moderator named organizational support (OS). These structures are shown in Figure 1.

### 4. Research Findings

The research results demonstrate convergent validity, which revealed the correlation between items. Alpha and composite reliability are more significant than 0.70, while factor loadings and extracted average variance (AVE) are greater than 0.50. These values indicated a significant correlation between the items listed in Table 2.

The study's results demonstrate the discriminant validity that revealed the correlation between variables. Fornell Larcker and cross-loadings were used to examine the discriminant validity in this study. The findings revealed that the figures that highlighted the construct's linkages were more prominent than those that highlighted the linkages with other constructs. These values indicated a minimal correlation between variables and are displayed in Tables 3 and 4.

Table 1. Items and Variables

Items	Questions	Sources
<b>Technological Linkages</b>		
THL1	The firm adopted transferred digital tools that improved the employee’s knowledge.	(Lazar et al., 2020)
THL2	The firm adopted transferred digital tools that enhance self-education.	
THL3	The firm adopted transferred digital tools that allow employees to complete the work more quickly.	
THL4	The firm adopted transferred digital tools that increased the employee’s learning performance.	
THL5	The firm adopted transferred digital tools that increase the employee’s learning efficiency.	
<b>Energy Efficiency</b>		
EEF1	Energy technologies may lead to better ways to clean up the environment.	(Park & Ohm, 2014)
EEF2	Energy technologies may help develop increased industrial competitive advantages.	
EEF3	Energy technologies may lead to better ways to treat and solve social problems.	
<b>Public Private Investment</b>		
PPI1	Knowledge transfer partnerships.	(Xie et al., 2022)
PPI2	Training and education on green innovation from the government-funded scheme.	
PPI3	Good practice or new skill sharing.	
<b>Organizational Support</b>		
OS1	The firm prides itself on the employee’s accomplishment.	(Islam & Ahmed, 2018)
OS2	The firm cares about the employee’s well-being.	
OS3	The firm values contributions to its values.	
OS4	The firm strongly considers the employee’s goals.	
OS5	The firm shows concern for the employees.	
OS6	The firm is willing to help the employees when they need a special favor.	
<b>Sustainable Performance</b>		
SPR1	"Technology helps decrease the cost of materials purchasing."	(Sheikh et al., 2018)
SPR2	"Technology helps decrease the cost of energy consumption."	
SPR3	"Reduction in waste caused by manufacturing activities can be decreased by new technology."	
SPR4	"Improvement in the firm environmental situation can be enhanced by introducing an innovative technology process."	
SPR5	"Incentives and employee engagement policies can be improved through intranet technology."	
SPR6	"New technology will help in the development of economic activities."	
SPR7	"Reduction of the negative impact of products and processes on the community can be monitored with the help of technology intelligence."	

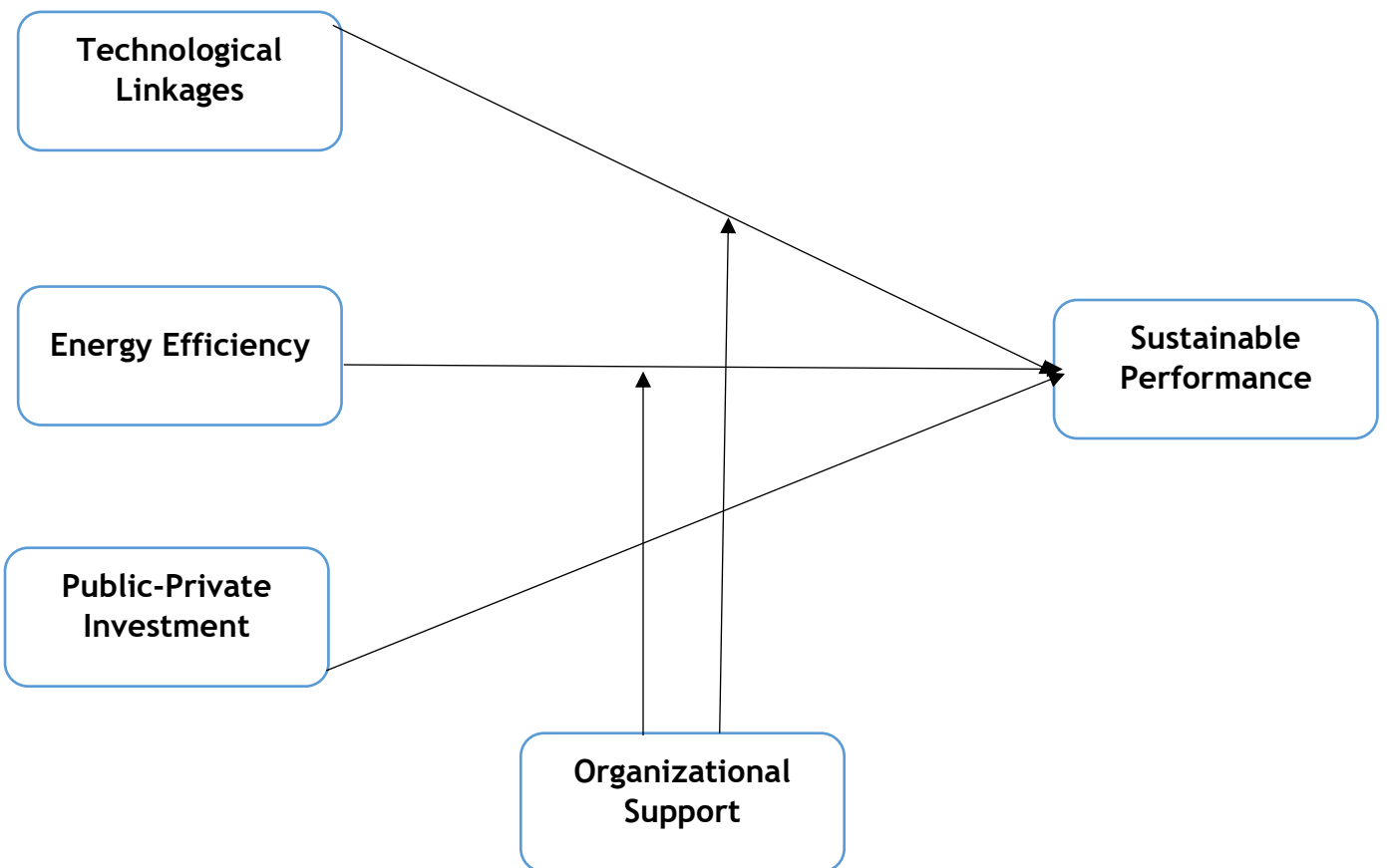


Figure 1. Theoretical Framework

Table 2: Convergent Validity

Constructs	Items	Loadings	Alpha	CR	AVE
Energy Efficiency	EEF1	0.921	0.785	0.873	0.698
	EEF2	0.857			
	EEF3	0.715			
Organizational Support	OS1	0.837	0.804	0.857	0.506
	OS2	0.832			
	OS3	0.565			
	OS4	0.547			
	OS5	0.649			
	OS6	0.776			
Public Private Investment	PPI1	0.874	0.833	0.899	0.749
	PPI2	0.854			
	PPI3	0.869			
Sustainable Performance	SPR1	0.616	0.843	0.880	0.514
	SPR2	0.768			
	SPR3	0.698			
	SPR4	0.801			
	SPR5	0.608			
	SPR6	0.694			
	SPR7	0.805			
Technological Linkages	THL1	0.824	0.838	0.888	0.616
	THL2	0.708			
	THL3	0.861			
	THL4	0.874			
	THL5	0.630			

Table 3. Fornell Larcker

	EEF	OS	PPI	SPR	THL
EEF	0.835				
OS	0.709	0.711			
PPI	0.477	0.580	0.865		
SPR	0.721	0.708	0.548	0.717	
THL	0.680	0.654	0.527	0.618	0.785

Table 4. Cross-loadings

	EEF	OS	PPI	SPR	THL
EEF1	0.921	0.837	0.447	0.700	0.648
EEF2	0.857	0.832	0.425	0.649	0.526
EEF3	0.715	0.565	0.302	0.402	0.539
OS1	0.921	0.837	0.447	0.700	0.648
OS2	0.857	0.832	0.425	0.649	0.526
OS3	0.715	0.565	0.302	0.402	0.539
OS4	0.244	0.547	0.328	0.278	0.292
OS5	0.351	0.649	0.505	0.372	0.301
OS6	0.477	0.776	0.506	0.430	0.361
PPI1	0.481	0.569	0.874	0.506	0.444
PPI2	0.376	0.481	0.854	0.462	0.466
PPI3	0.376	0.449	0.869	0.453	0.460
SPR1	0.357	0.462	0.503	0.616	0.528
SPR2	0.493	0.464	0.372	0.768	0.548
SPR3	0.376	0.358	0.325	0.698	0.376
SPR4	0.462	0.450	0.389	0.801	0.481
SPR5	0.334	0.294	0.354	0.608	0.321
SPR6	0.643	0.627	0.391	0.694	0.585
SPR7	0.765	0.719	0.410	0.805	0.637
THL1	0.396	0.437	0.364	0.533	0.824
THL2	0.658	0.579	0.477	0.617	0.708
THL3	0.381	0.417	0.428	0.554	0.861
THL4	0.440	0.469	0.372	0.571	0.874
THL5	0.777	0.648	0.407	0.513	0.630

The study's results demonstrate the discriminant validity that revealed the correlation between variables. Heterotrait Monotrait (HTMT) ratio was used to determine the discriminant

validity in this study. According to the results, the figures are less than 0.90. These values indicated a minimal degree of correlation between the variables listed in Table 5.



Table 5: Heterotrait Monotrait Ratio

	EEF	OS	PPI	SPR	THL
EEF					
OS	0.633				
PPI	0.576	0.717			
SPR	0.812	0.764	0.650		
THL	0.844	0.763	0.630	0.820	

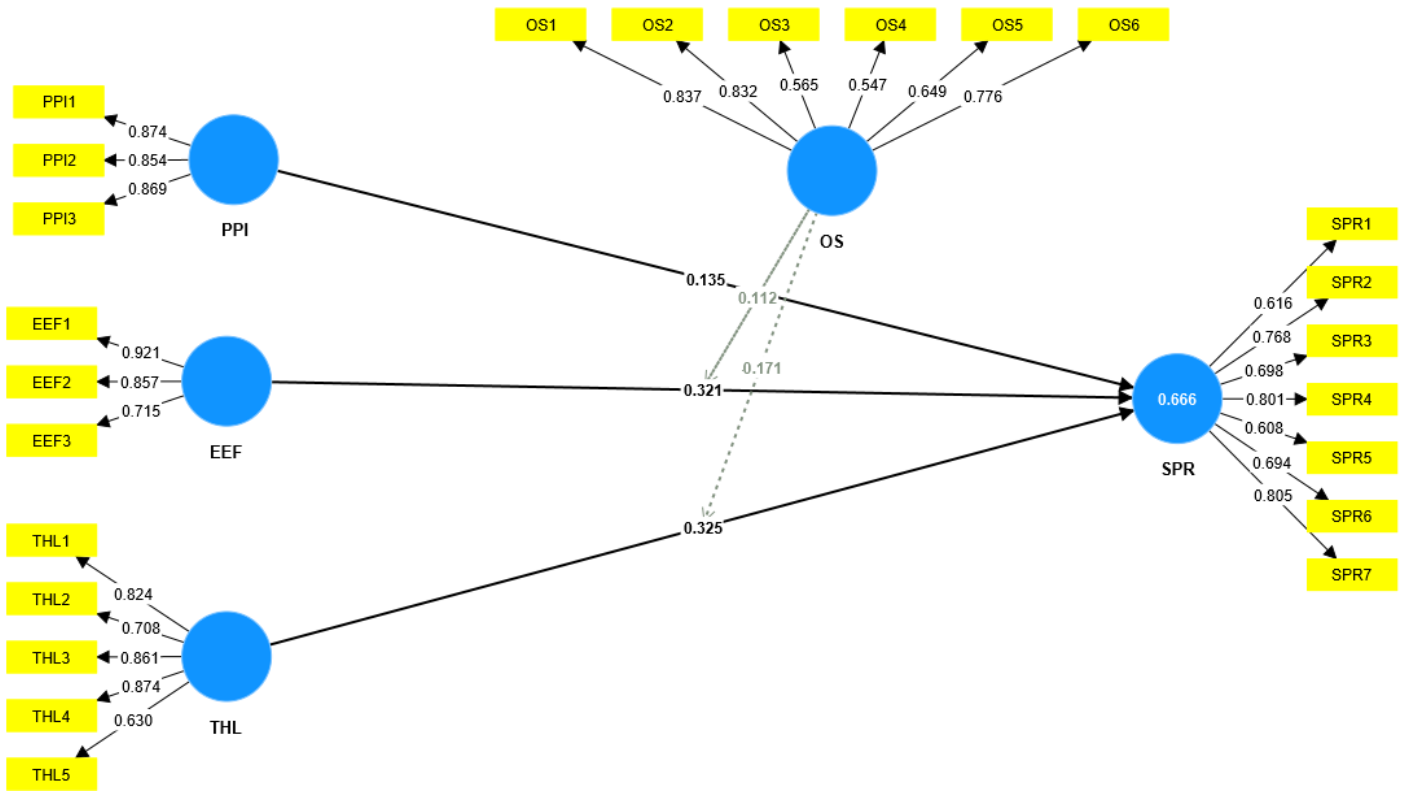


Figure 2. Measurement Model Assessment

The results indicated that technological linkages, energy efficiency, and public-private investment have positive relationships with the sustainable performance of SMEs in the Southern Key Economic Zone, so H1, H2, and H3 can be accepted. In addition, the results demonstrated that

organizational support moderates' technological linkages, energy efficiency, and sustainable SME performance in the Southern Key Economic Zone and adopts hypotheses H4 and H5. These connections are shown in Table 6 and Figures 2 and 3.

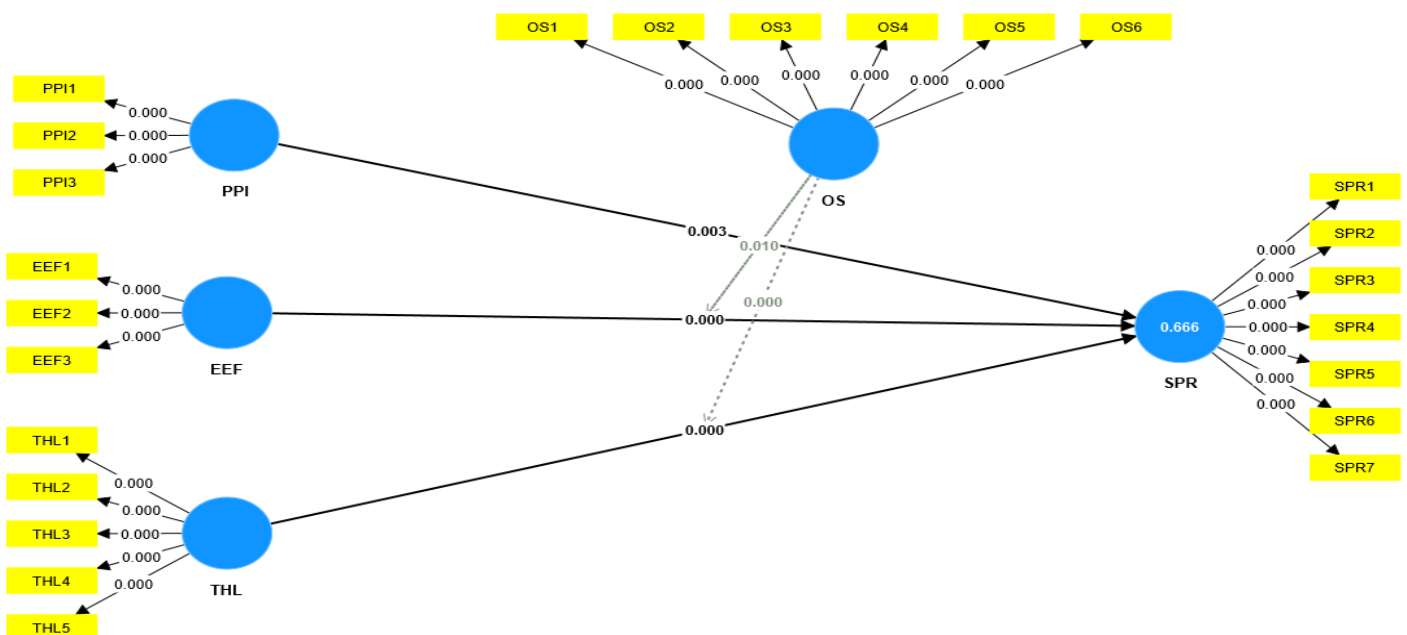


Figure 3. Structural Model Assessment

Table 6: Path Analysis

Relationships	Beta	Standard Deviation	T Statistics	P values
EEF -> SPR	0.321	0.070	4.576	0.000
PPI -> SPR	0.135	0.046	2.958	0.003
THL -> SPR	0.325	0.052	6.232	0.000
OS x EEF -> SPR	0.112	0.044	2.574	0.010
OS x THL -> SPR	0.171	0.039	4.422	0.000

## 5. Discussions

The outcome demonstrated that technological linkages positively affect the sustainable performance of SMEs in Vietnam's Southern Key Economic Zone. Technological connections provide organizations with various innovative facilities that aid in achieving sustainability objectives. This hypothesis was validated by a previous study by [Haseeb et al. \(2019\)](#). They studied Malaysian SMEs, gathered data from 500 managerial personnel, and employed structural equation modeling as a methodological device. According to them, technological factors play a crucial role in addressing the environmental crisis and assist businesses in gaining a competitive advantage.

In addition, another study by [Haseeb et al. \(2019\)](#) found that Industry 4.0 plays a vital role in enhancing the firm's sustainability performance. This investigation was conducted in Thailand utilizing the PLS-SEM methodology. According to the companies, innovative technologies generate a competitive market position and a favorable brand image.

The results demonstrated that energy efficiency positively influences the company's sustainable performance. This hypothesis is supported by [Nietl et al.'s \(2019\)](#) study. They have reviewed the relevant literature and determined that energy efficiency policies and strategies play a significant and crucial role in enhancing the company's sustainable performance. [Zakari et al. \(2022\)](#) conducted additional research that supported this hypothesis. According to them, energy efficiency is essential for minimizing waste and optimizing resources. Various energy-efficient technologies and instruments can be employed to promote sustainable business practices.

The results indicate that private-public investment positively affects the sustainable performance of the company in the Southern Key Economic Zone. [Liu et al.'s \(2002\)](#) research supported this hypothesis. They analyzed the data using the Quantile ARDL technique. In their studies, they also noted that investments provide opportunities for SMEs to form partnerships with larger companies, thereby assisting them in achieving their sustainability objectives. In addition, [Z. Khan et al. \(2020\)](#) conducted another study that supported this hypothesis. Various methodologies, including CCR, FMOLS, and GLS, have been employed to analyze the results. According to them, firms that receive investments from external entities such as the government, investors, or stakeholders will receive assistance deploying unique tools and techniques that contribute to the firm's sustainability.

The results indicate that organizational support moderates the relationship between technological links and the sustainability performances of firms in the Southern Key Economic Zone. According to research conducted by [Karatepe et al. \(2022\)](#), organizational support is crucial to the sustainability of businesses. According to them, organizational support through incentives, resources, and training will provide businesses with innovative technologies that improve sustainability. In addition, a study by [Yali Zhang et al. \(2020\)](#) highlighted the importance of organizational support, which enables firms to implement technological linkages, improving sustainability performance. Their investigation used both confirmatory and exploratory factor analyses to analyze the results. In their

research, they also noted that organizational support is crucial not only for the successful integration of green technologies but also for obtaining a competitive advantage.

The findings demonstrated that organizational support moderates Southern Key Economic Zone firms' energy efficiency and sustainability performances. [Wen et al.'s \(2000\)](#) studies supported this hypothesis. The results have been analyzed using the difference in difference model. According to them, organizations should invest in R&D, resources, and training for their employees so that they can excel at achieving sustainability objectives through energy-efficient techniques. Organizations use new processes and technologies to alter the business environment in the current era. To obtain a competitive advantage, small and medium-sized enterprises (SMEs) must equip themselves with innovative knowledge and information for energy-efficient processes, which can be made possible through organizational support. [Meng et al. \(2018\)](#) conducted additional research that supported this hypothesis. In their research, the PRISMA framework was utilized. To assess energy-efficient strategies, they determined that managers must provide support through funds, training, or seminars to improve the company's sustainability performance.

## 6. Theoretical Implications

This paper makes a significant contribution to the body of knowledge. Researchers, industrialists, government agencies, and non-governmental organizations have greatly emphasized sustainability due to increased environmental issues. Increases in greenhouse gas emissions, carbon footprints, waste materials, and depletion of natural resources have posed grievous environmental threats. Organizations, governments, and non-governmental organizations must collaborate to implement sustainable business practices to create a sustainable environment and preserve natural resources for future generations. This paper examines the impact of technological linkages, energy efficiency, and organizational support for private-public investment on the sustainable performance of small and medium-sized enterprises (SMEs). To create a positive brand image and compete in the market, businesses must prioritize maximizing benefits and incorporating sustainable practices. This document examines how innovative technologies, energy-efficient techniques, investments or funding, and organizational support can enhance the sustainability of businesses. Due to a lack of funding, resources, or investment, SMEs encounter difficulties implementing these sustainability processes, but these factors can help businesses become environmentally friendly.

## 7. Managerial Implications

The Vietnamese government has endeavored to incorporate sustainable practices in their industries in recent years. Numerous organizations, particularly small and medium-sized enterprises, have realized that a positive brand image is essential for market competition. Customers, investors, and stakeholders are aware of green and sustainable products and are concerned with humans' well-being and quality of life. To remain competitive, small and medium-sized enterprises (SMEs) do their best to equip themselves with technologies, processes, or strategies promoting environmental sustainability. Vietnam's small and medium-sized enterprises

(SMEs) contribute significantly to the country's gross domestic product but also confront environmental challenges. Government and regulatory agencies are encouraging industries to minimize the negative environmental impact of their operations. This paper concluded that technological linkages, energy efficiency, and private-public investments are crucial for the long-term viability of small and medium-sized enterprises (SMEs) in Vietnam's Southern Key Economic Zone. Businesses cannot implement sustainable practices without technological connections, as they provide innovative and distinctive solutions.

Additionally, energy efficiency facilitates the development of energy-saving processes that minimize resource consumption and maximize profit. The research assists policymakers in formulating policies for sustainable performance through effective technological links, energy efficiency, and public-private investment. Without funding or buying, it would be impossible for businesses, particularly SMEs, to implement green practices, as SMEs lack significant investments. It would enable them to become environmentally friendly and self-sufficient. In addition, organizational support moderates' technological assistance, energy efficiency, and sustainable performance. Additionally, administrative support in the form of training, incentives, and resources would aid employees in prioritizing the firms' profit and sustainability objectives.

## 8. Limitations

This article makes significant contributions to the existing body of knowledge but also has limitations that can be surmounted in the future. This paper begins by analyzing the effect of technological linkages, energy efficiency, and private-public investment on the firm's sustainable performance. Future research could also examine the impact of financial incentives and team managers on sustainable performance. Second, this paper used organizational support as a moderator to explore the relationship between technological linkages, energy efficiency, and sustainable performance. Future research can use government and technical support as a moderator to examine the relationship between technological linkages, energy efficiency, and the firm's sustainable performance. Thirdly, this research was conducted on the SME sector in the Southern Key Economic Zone of Vietnam, which places it in a developing nation. This suggests that this study may not apply to a developed nation. This model can be used to analyze the impact of these factors on the developed nation for future reference.

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