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Green Performance: Critical factors from Malaysian electrical and electronics suppliers

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Abstract
The objective of the study is to identify critical factors influencing suppliers' environmental performance. Employing survey methodologies, a cross-sectional study was conducted, analysing 110 completed survey questionnaires from electrical and electronic suppliers. The findings revealed that suppliers' green performance is significantly influenced by quality practices, technical competence, a green image, and environmental management, although not by pollution control. In light of the growing importance of environmental achievements for market competitiveness, these results offer valuable insights for manufacturers seeking to enhance suppliers' green performance. Future studies should explore additional crucial factors impacting suppliers' environmental accomplishments.

Keywords: Electronic; Environmental; Green; Performance; Supplier

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1.0 Introduction

In today's ever-evolving global and competitive business landscape, selecting suitable suppliers is one of the most crucial processes to enhance a firm's quality, cost, and delivery performance. Furthermore, waste in our world originates from many sources and sectors, from primary suppliers of raw materials to key players within the manufacturing industries (Shaharudin et al., 2023). Companies are under more pressure to consider the environmental aspects in producing and delivering their goods and services (Zhang et al., 2014). Therefore, selecting green suppliers can be the most crucial aspect because it will not only improve the company's environmental performance and image but also help them achieve environmental goals and protect the environment (Büyüközkan & Çifçi, 2011). A previous study indicated that 60% of suppliers that used Green Supply Chain Management (GSCM) methodologies can increase profitability and savings during purchasing and production and give them an advantage over their competitors. Companies can improve their environmental performance by cooperating with suppliers on environmental issues (Gurel et al., 2015). Nevertheless, suppliers may see it as an additional burden and costly to transform from a traditional supply chain to a green supply chain performance.

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With the increasing ill effects of industrial developments and consumption levels, environmental consideration has been one of the most crucial problems for suppliers to protect the environment. Based on the Supply Chain Intelligence Report 2009, 40% of the suppliers needed to perform ecologically economical business techniques and be willing to do so. Suppliers may even see it as an additional burden and costly to transform from a traditional supply chain to a more environmentally green one. The lower tiers of suppliers are the least prepared to handle sustainability requirements. They frequently need more knowledge of sustainability and resources and might need to be more familiar with customary social and environmental norms.

Additionally, they often have little knowledge of the sustainability standards set by MNCs and lack the motivation to meet the requirements. This could be the reason why the majority of the lower-tier suppliers lacked environmental management plans as well as programs to dispose of toxic waste. (HBR, 2020). If the company dreams of having a green supply chain, it must select suppliers with green practices (Yee et al., 2021). Supplier selection criteria such as environmental, social, and economic practices must be considered by the companies that want to choose green suppliers (Govindan et al., 2013). Environmental issues have caught the attention of companies globally, institutions, and citizens, and it has become the strategic topic for most manufacturing companies in selecting the greenest suppliers. Hence, the study aims to identify the factors affecting suppliers' environmental performance. Among the benefits to the organization is providing the knowledge to improve the supplier's green practices and increase green performance. This study will benefit the organization by giving them ideas to enhance their company for better performance and to satisfy the customers.

2.0 Literature Review

2.1 Green Performance

The supplier's green performance becomes an essential factor for the manufacturer to enhance the firm competitiveness. Besides quality, time to market, and cost, environmental friendliness is among the most important criteria for assessing the supplier's performance (Agarwal & Vijayvargy, 2012). Suppliers need assistance from the focal firm because they cannot increase their green performance. As a result, to improve their environmental capabilities, firms must educate their suppliers about environmental concerns, assess their performance in terms of becoming green, and maintain a positive working relationship with them.

The performance of green suppliers is more significant nowadays. The elimination of hazardous waste, adoption of green technology, goods, and practices, and reduction of environmental emissions are on the priority lists of several organizations. The business is conducting an examination to ensure the supplies it has acquired from suppliers are of good quality. Suppliers are known to have difficulty providing environmentally acceptable materials or components for creating green goods (Kermani et al., 2011). If raw material providers use dangerous or toxic chemicals, the supply chain will experience significant environmental issues. As a result, major firms' long-term operations, competitiveness, and supply chains must include environmental considerations in supplier activities and engage with suitable green suppliers (Zhang et al., 2014).

2.2 Quality Practices

Walton (1998) advocated that companies that implement total quality environmental management into their operations and planning have the opportunity to succeed. Implementing environmental criteria for procurement with suppliers can ensure that the final products meet the desired environmental quality standards demanded by both customers and stakeholders (Shaharudin et al., 2018). The companies have implemented supplier development programs to ensure the materials and services suppliers supply are high quality and according to environmental criteria. Companies will benefit from using high-quality materials such as rework, defect, and waste reduction. Some studies suggest that environmental practices and a company's effectiveness can be increased by implementing quality management practices such as supplier total quality management (TQM) and ISO 9001 certification (Pereira-Moliner et al., 2012). The proof that has been found by Weingarten and Pagell (2012) advocated that when environmental management practices exist due to high investment in quality practices, companies will enhance their performance in terms of flexibility, delivery performance, and cost. Thus, this study hypothesised:

H1: Quality practices positively influence suppliers' green performance.

2.3 Technology Capability

Green technology aims to meet customer needs by reducing the negative environmental impact, such as lowering production costs and greenhouse gas emissions. The short life cycle of products and continuous technological changes make companies improve their green innovations to boost their competitive advantage. According to Rehman et al. (2016), suppliers must set their environmental policies that focus on planning purposes and must be implemented in the production process because the processing of raw materials is the most significant energy expenditure. Therefore, the suppliers need the technical capability to produce less waste and reduce defects to prevent the high energy cost of correcting them (Gurel et al., 2015). Thus, this has led to the following hypothesis:

H2: Technology capability positively influences suppliers' green performance.

2.4 Green Image

Companies can build a positive image from the customer by producing safe and reliable products. This includes a positive impact on their production processes due to having green products from their environmental management practices (Wu & Barnes, 2016).

Companies can increase their profits, improve their corporate image, and expand the market by producing green and superior-quality products (Govindan et al., 2013). The negative impact on the environment can be reduced if suppliers improve their product design in the supply chain, maintain sustainability, and strengthen the environmental image of the company (Büyüközkan & Çifçi, 2011). Chang and Fong (2010) revealed that a green Image has positively influenced supplier performance regarding green customer loyalty and satisfaction. Thus, it is clear that a green image is one of the essential sources of customer satisfaction for green products. A company's green image can be an essential measure for the customer to know whether the quality of the unfamiliar products is good or bad. Then, top management must develop and sustain their green image to improve performance. As stated by Li (2011), a company's green image will be damaged if they have poor green performance by the suppliers, so they must provide suppliers with explicit environmental knowledge to ensure good performance. Thus, the following hypothesis has been derived:

H3: Green Image positively influences suppliers' green performance.

2.5 Pollution Control

Pollution control through end-of-pipe resolution is a common practice to protect the environment. For instance, in industrial applications, the recycling and reutilization of batteries offer dual benefits by reducing environmental pollution caused by hazardous components in discarded batteries and addressing the scarcity of resources such as lithium and cobalt (Ishak et al., 2023). Pollution reduction and environmental protection are the primary goals of the green supply chain. Companies can assist suppliers in identifying solutions for environmental problems and help them to make better improvements. Pollution reduction and improving other environmental problems are primary goals of the green supply chain, and they must help suppliers identify the significance of having a solution for environmental problems and help them make better improvements. Companies aim to reduce the use of these harmful materials because they can significantly cause pollution. As such, companies must establish pollution control programs that provide knowledge about the proper usage of energy utilization. Hence, this leads to the following hypothesis:

H4: Pollution control positively influences suppliers' green performance.

2.6 Environmental Management

Environmental management supports better regulatory compliance management, minimizes environmental risk, improves public reputation, and improves the utilization of employees and resources (Tinsley & Pillai, 2006). Suppliers should use less packaging, decrease energy consumption, and minimize pollution in their products and services. An environmental management system (EMS) guides companies in continually improving green performance, productivity, and compliance. According to Igarashi et al. (2013), suppliers' green performance can be identified based on criteria such as environmental management certification, compliance with environmental policies and regulations, and training their staff on environmental awareness. According to Wu et al. (2014), he stated that the relationship between green supply chain and environmental management strategies affected firm performance improvement. Strategic green supply chain partnerships are essential for effective environmental management. Accordingly, this study puts forth the following hypothesis:

H5: Environmental management positively influences suppliers' green performance.

The study's conceptual framework in Figure 1 has been developed based on the preceding discussion.

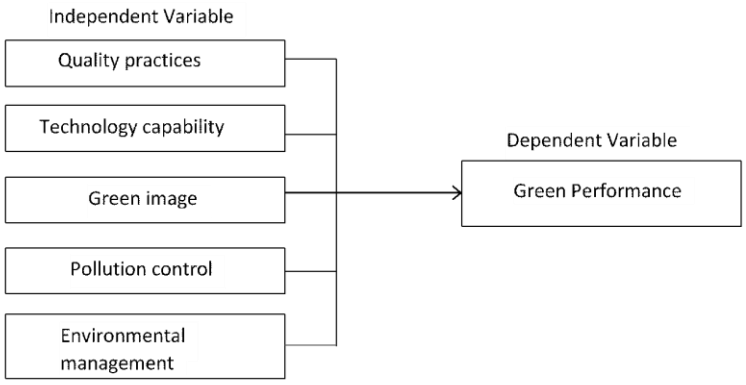

Figure 1. Conceptual Framework

3.0 Methodology

The study was designed with a quantitative research approach, adopting a cross-sectional study design within a specified time horizon. The unit of analysis centered on the organizational context. Employing a survey methodology, data were collected from a diverse pool of 200 electrical and electronics suppliers located in the industrial expanse of Penang, Malaysia. This region is home to a spectrum of

factories, ranging from local enterprises to multinational corporations (MNCs). In this vibrant setting, encompassing various scales of industrial operations, the study strategically gathered responses. Purposive sampling was employed in this study. Out of the 200 questionnaires distributed, a robust 55% response rate was achieved, yielding 110 usable responses. These responses underwent rigorous scrutiny in subsequent analyses, contributing valuable insights to the study's findings.

4.0 Data Analysis

4.1 Demographic and Business Profile

Most respondents are male, 54.50%, working in a manager position, 39.4%, with working experience between 6 to 10 years, and working with the present company between 0 to 5 years, 38.2%. As for the company years of operations, most of the companies have been in operation for more than 25 years at 31.8%, local company ownership at 47.3%, and the nature of manufacturing business at 70.0%.

4.2 Measurement Model

Based on Table 1, all factors' loadings exceeded the recommended value 0.6 (Hair et al., 2010). As for the Composite Reliability (CR), the variable has exceeded the acceptable value of 0.7 and higher. The Average Variance Extracted (AVE) showed that all variables exceeded the recommended value of 0.5 and above (Hair et al., 2010). Hence, the results signified compliance with the measurement model requirements.

Table 1: Measurement Model Evaluation

Latent Variables	Factor Loading	Composite Reliability (CR)	Average Variance Extract (AVE)
Quality Practices	0.715-0.785	0.845	0.578
Technology Capability	0.657-0.783	0.807	0.513
Green Image	0.631-0.806	0.820	0.535
Pollution Control	0.729-0.781	0.865	0.502
Environmental Management	0.763-0.845	0.880	0.562
Green Performance	0.726-0.775	0.870	0.573

Table 2 shows the evaluation of discriminant validity using Fornell and Larcker's (1981) approach. The results implied that the square root of AVEs was higher than correlations for each variable, indicating adequate discriminant validity has been achieved.

Table 2: Fornell-Lacker Criterion Analysis

	1	2	3	4	5	6
1. Environmental Management	**0.805**					
2. Green Image	0.485	**0.731**				
3. Pollution Control	0.458	0.566	**0.750**			
4. Quality Practices	0.233	0.422	0.428	**0.760**		
5. Suppliers Green Performance	0.435	0.633	0.470	0.485	**0.757**	
6. Technology Capability	0.202	0.290	0.366	0.341	0.451	**0.716**

4.3 Structural Model

The study's hypotheses were tested using the nonparametric bootstrapping with 5,000 replications of the sub-samples. Table 3 shows the path analysis results.

Table 3: Path Analysis Results

Hypothesis	Path	Beta	t-Value	Decision
H1	Quality Practices > Supplier's Green Performance	0.198*	1.983	Supported
H2	Technology Capability > Supplier's Green Performance	0.235**	2.743	Supported
H3	Green image> Supplier's Green Performance	0.412***	3.594	Supported
H4	Pollution Control > Supplier's Green Performance	0.002	0.020	Not Supported
H5	Environmental Management > Supplier's Green Performance	0.141**	2.661	Supported

As shown in Table 3, using a one-tailed test of above 1.645 of T-statistics for the significant path co-efficient, the results revealed that quality practices positively significantly influenced supplier's green performance (T-stats is 1.983), technology capability impacted supplier's green performance (T-stats is 1.743), green image influenced supplier's green performance (t-stats is 3.594) and environmental management affected the supplier's green performance (t-stats is 1.661). Nevertheless, pollution control results do not impact the supplier's green performance (t-stats is 0.020). Hence, H1-H2, H3, and H5 were supported, except H4, which was not supported. Further testing of the prediction relevance of the model indicated that all Stone-Geisser's Q^2 values for all the exogenous latent variables were higher than 0.00, signifying that the model is well constructed and has predictive relevance (Chin, 2020).

5.0 Discussion

The results indicate that quality practices are critical in increasing the supplier's green performance. Total Quality Environmental Management (TQEM) is an effective strategy to improve the business's environmental performance. Waste and pollution reduction can make it easier to follow environmental laws and sound business practices (Shaharudin et al., 2022). Additionally, implementing TQEM practices will save costs by recycling waste, conserving energy, and preventing environmental problems before they become serious. A corporation must improve quality methods like continuous quality improvement if it wants to increase customer satisfaction. According to Bai & Sarkis (2010), the primary objectives of TQEM are the quality improvement and environmental management approach to reducing and removing all waste streams in their manufacturer, the design of a product, disposal, and usage.

The findings also indicate that technology capability positively affected the supplier's green performance. Green technology aims to meet customer needs by reducing the negative environmental impact, such as lowering production costs and greenhouse gas emissions. Foo et al. (2019) state that suppliers must establish environmental policies centered on planning objectives and put them into practice during production because processing raw materials uses the most energy. To avoid using a lot of energy to fix a problem, suppliers must have the technical competence to generate less waste and reduce defects (Yee et al., 2021).

Moreover, the research has revealed that a green image positively affects the supplier's green performance. The green image favors supplier performance in terms of green customer loyalty and satisfaction (Chang & Fong, 2010). It follows that the green image is one of the critical factors in customers' happiness with green products. A company's environmental reputation can be a crucial indicator for a buyer to determine whether the quality of unfamiliar items is good or not. Moreover, senior management must cultivate and maintain the company's green image to enhance its performance.

The study results indicate that pollution control does not significantly impact the supplier's environmental performance. This is owing to the suppliers' increased focus on pollution prevention technologies rather than pollution control technologies, as the former will result in zero waste and better performance financially. At the same time, the latter will cost more to adopt due to waste disposal. Additionally, pollution prevention is longer-term and more effective than pollution control since it uses less energy and raw materials, which lowers operating costs. Utilizing pollution prevention technologies will enable suppliers to manage process quality issues and waste disposal with less effort, which will increase their market shares.

Finally, the results of this study demonstrated a significant relationship between environmental management and the supplier's green performance. Environmental management is one of the most important aspects because most customers, employees, competitors, communities, and governments are concerned with protecting the environment. One sign is that most suppliers have begun to use the ISO 14001 standard to deal with environmental issues. According to Igarashi et al. (2013), the green performance of a supplier can be determined based on their criteria, such as whether they have an environmental management certification, abide by environmental policies and regulations, and educate their workers about the environment. When a business manages its environmental impact effectively, it can lessen environmental problems while increasing profits, productivity, efficiency, and market share (Shaharudin et al., 2015).

6.0 Conclusion

In this study, the supplier's green performance is measured by its quality practices, technology capabilities, green image, pollution control, and environmental management. The results demonstrated that quality practices, technical competence, a green image, and environmental management significantly influence the supplier's green performance. However, pollution control was found not to significantly affect the supplier's green performance, mainly due to the focus of suppliers on pollution prevention rather than pollution control measures. The implications of these findings are significant for manufacturers aiming to enhance suppliers' green performance. Understanding that quality practices, technical competence, a positive green image, and effective environmental management are vital influencers can guide strategic decisions. Future research should include studies of other industries and the electrical industry. This will help the researcher learn more about the critical factors influencing the supplier's green performance.

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Paper Contribution to Related Field of Study

This study benefits the understanding of green performance within the context of the Malaysian electrical and electronics industry.

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