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AN EMPIRICAL STUDY ON THE INFLUENCE OF SUSTAINABLE ENVIRONMENTAL MANUFACTURING PRACTICE ON FIRM PERFORMANCE

HAMEED O. ADEBAMBO*, HASBULLAH ASHARI AND NORANI NORDIN

School of Technology Management & Logistics, Universiti Utara Malaysia, 06010 Sintok-Kedah, Malaysia.

Corresponding author: segham003@yahoo.com

Abstract: Environmental problem has been linked to the operational activities of manufacturing firms as they yield production with economic values under the guidance of environmental regulation. Hence, sustainable environmental practice is one of the critical factors in the competition and performance among manufacturers. This study investigates the influence of sustainable environmental manufacturing practices (SEMP) on firm performance. A survey questionnaire was used to collect data from 103 manufacturing companies in Malaysia and it was analysed with SmartPLS. The result found a significant relationship between SEMP and environmental performance, but could not find an evidence of a significant relationship between SEMP, and financial and operational performance. This implies that SEMP is yet to be considered as a strategic resource in achieving competitive advantage and better firm performance among manufacturing companies. Therefore, the study suggests that the environmental policy maker should create more awareness to enlighten the manufacturing practitioners not only to perceive sustainable environmental practices as ethical but also as a strategic factor in achieving better firm performance.

Keywords: Firm performance, sustainable manufacturing environmental practices, ethical behaviour, strategic factor.

Introduction

Manufacturing firms contribute positively to economic development, especially in the aspect of employment opportunities and gross domestic products. However, statistical evidences have revealed that manufacturing industries usually contribute adversely to the environment. It is evident in the report of the Environmental Investigation Agency (EIA, 2007) that manufacturing industries are significantly responsible for the consumption of a huge amount of resources as well as for the generation of waste throughout the world. Notably, in Malaysia 30% of energy was consumed by manufacturing industries in 2012 (Suruhanjaya, 2014). It was also responsible for about one third of the global usage of energy and 36% of the total carbon dioxide (CO_2) emission in the world (OECD, 2009).

Manufacturing sector is responsible for a large portion of the environmental degradation in Malaysia. This is witnessed in the increasing volume of generated waste from stationary sources of industries (DOE, 2012). In addition, the result of the analysis of the Water Quality Index shows that there has been a continuous rise in the amount of Biochemical Oxygen Demand (BOD_5) in river basins as a result of the untreated or partially treated sewage discharge from the manufacturing industries (Compendium of Environmental Statistics, 2012). BOD_5 refers to the quantity of dissolved oxygen needed for the bacterial decomposition of organic wastes in water samples. In the aspect of energy consumption, manufacturing consumes huge energy in Malaysia (Al-Amin *et al.,* 2009). In addition to the adverse effect of manufacturing on the environment, the demand for water has continued to rise in Malaysia. National Water Resources Study (Peninsular Malaysia) asserts that water demand is expected to rise by 63% between year 2000 and 2050 (Hock, 2008). Therefore, there is a high need for sustainable environmental practices in manufacturing industry in order to reduce the adverse environmental impacts of industrial activities and to sustainably manage its resources to ensure social, economic, and environmental development (CES, 2012).

Traditionally, association exists between manufacturing firms and the undesirable

environmental negative impacts (Despeisse, Ball & Evans 2012; Frosch & Gallopoulos, 1989). Environmental problem has been linked to the operational activities of manufacturing firms (Holdren & Ehrlich, 1974) as economic values are produced by manufacturing firms by transforming resources input into useful output under the guidance of environmental regulation (Gutowski, Branham, Dahmus, Jones, Thiriez, & Sekulic, 2009). As such, environmental practice has become a vital global issue that creates challenges for the society and manufacturing practitioners (Jovane, Yoshikawa, AltingBoër, Westkämper, Williams, Tseng, Seliger, & Paci, 2008).

Presently, sustainability issues have become a critical factor of competition and firm performance (UNEP, 2011) among manufacturers. Thus, it compels many manufacturing firms to include sustainable environmental practices in their strategies and operations (Amrina & Yusof, 2011). However, authors on environmental practices affirmed that the concerns of firms about environmental issues are not only about their environmental values, but also about the economic success and performance of their organizations (Henri & Journeault, 2008). A firm may initiate environmental practices either as an ethical behaviour (Bansal & Roth, 2000) or as a critical factor in achieving competitive advantage and better firm performance (UNEP, 2007; Schoenherr & Talluri, 2012). Therefore, this study seeks to investigate the influence of sustainable environmental manufacturing practices on firm performance.

Sustainable Environmental Manufacturing Practices and Firm Performance

Sustainable Environmental Manufacturing practice (SEMP) is regarded as the initiatives responsible for the technical and organisational activities exhibited by firms to minimize its impact on the natural environment (Omar & Samuel, 2011). Schoenherr and Talluri (2012) viewed sustainable environmental practices as techniques, policies and the procedures taken by a firm with the specific aim of monitoring and controlling the effects of the operations of the firm on the natural environment. Firm performance on the other hand, refers to the firms' activities that focus on the achievements of its objectives. It entails: the financial performance, operational and environmental performance.

As posited by the natural resource based view (NRBV) theory, organizations can achieve competitive advantages and better firm performance by incorporating sustainable environmental manufacturing practices (Hart, 1995). The NRBV lays emphasis on the firm's resources, capabilities and the management of the firm's strategic action as influencing the relationship between SEMP and firm performance. Thus, the natural environment within which firm operates can enhance better performance if it is strategically managed. The emphasis on NRBV has encouraged researchers to identify the link between firms' sustainable environmental practices and performance.

Several studies (Ameer & Othman, 2011; Lopez-Gamero *et al.,* 2009; Chen & Shih, 2007; Wagner, 2005; Zhu & Sarkis, 2004) have investigated the relationship between environmental sustainable practices and performance of firms and found that SEMP positively influence the firm performance. According to Lopez-Amero *et al.*, (2009) environmental productivity has a significant effect on firm performance. Among the Chinese industries, Chin & Shih (2007) found that green manufacturing practices have positive influences on financial performance. In addition, the influence of emission reduction was confirmed to improve the operating and financial performance among manufacturing industries. Hence, a positive influence of sustainable environmental manufacturing practices is posited on firm performance in this study.

In a similar vein, environmental activities such as product life cycle analysis, collection and use of the reusable parts and components of the products are intended towards reducing environmental degradation. These create avenues for the identification of the areas that

are required to improve the quality of products. If the quality is ensured from the beginning of operations, it may avoid rework and reduce the cost of manufacturing operations and detriments due to waste disposal (Lai & Wang, 2012). Literatures have found that firms that implement sustainable environmental practices will gain better plant efficiency (Schoenherr & Talluri, 2012). According to Lai and Wong (2012), environmental management practices positively improves operational performance in green logistic. Also, Tooru (2001) confirmed that environmental practices and operational performance are positively related.

There has been a growing concern on firm performance as an outcome of sustainable environmental manufacturing practices. Generally, a trade-off exists between environmental proactivity and firm productivity (Porter & Van der Linde, 1995). However, the quest for an environmental goal in firm is usually cost intensive at the beginning of the implementation, but beneficial in the long-run in term of cost savings and financial performance (King & Lenox, 2001). Environmental practices that include energy saving, reduce of carbon emission, and waste reduction reduces environmental degradation from firms operations and improves the performance of firms in term of environmental performance. This was asserted by Zhu and Sarkis (2004) who stated that there is a direct positive relationship between environmental practices and environmental performance of firms.

In regards to the discussions above, the following hypotheses are presented between sustainable environmental manufacturing practices and firm performance:

H1: *Sustainable environmental manufacturing practices will positively influence financial performance.*

H2: *Sustainable environmental manufacturing practices will positively influence operational performance.*

H3: *Sustainable environmental manufacturing practices will positively influence environmental performance.*

Method

This study employed a quantitative approach conducted in a cross-sectional design. The population of the study is the manufacturing industry in Malaysia. A total of two thousand four hundred and seventy six (2476) manufacturing companies was registered with the federation of Malaysian manufacturers (FMM) (FMM, 2013) which represent the sample frame from which the sample of the study was selected. However, the study exempted those companies with full-time employees lesser than 50 from the study due to their financial and technological inability (Carter *et al.,* 2009; Sidek & Backhome, 2014). Hence, the final population size retained in the study is 1580 companies and which was used in the study.

Krejcie and Morgan (1970) provided that a given population of 1500 will be represented by 306 samples, while a population of 1600 is represented by sample size 310. Thus, it can be deduced that the sample size of the population of 1580 for this study ranges between 306 and 310 samples. Hence, a computed sample size 309.181 (rounded up to 310) is determined and used in this study. The sample was selected from this population by using a stratified random sampling method. This involves the process of segregating the population into strata (DeVaus, 2002) which was followed by randomly selecting the subjects from each stratum (Sekaran & Bougie, 2009). This Sampling method was used to ensure that the characteristics of the population are proportionately represented by each stratum and to guide the choice of the researcher from bias (Babbie, 1990; Miller, 1991).

This study used a survey questionnaire for data collection because of its ability to provide an efficient use of the time, energy and costs of the researcher (Sekaran & Bougie, 2009). The research questionnaires were administered to the respondents via postal mail. This was chosen because of its ability to cover a wide geographical area and the provision for the respondents to complete the questionnaires at their convenience. Items of the questionnaire used were adapted from past studies and were

measured on a 6-point Likert type scale of 1- 6 in which "1" indicates strongly disagree and "6" indicates strongly agree. Specifically, measurement items for SEMP were adapted from Gonzalez-Benito & Gonzalez-Benito (2006), items for financial performance were adapted from Henri & Journeault (2008), while items for operational and environmental performance were adapted from Lai & Wong (2012).

A total of 790 survey questionnaire was distributed to the respondents and 103 usable questionnaires was returned and used for the data analysis. This represents a 13% response rate, similar to the 12% obtained by Wong *et al.* (2011) and 11.5% by Ahmed & Hassan (2003) within the context of Malaysia. Thus, the 13% response rate in this study is considered reasonable and was used for the analysis. This was done by using the smart PLS 2.0 M3 (Ringle *et al.,* 2005) path modeling software. PLS-SEM offers several advantages such as emphasizing minimum requirement on sample size to predict significant relationship size, ability to analyse complex model with accuracy, and places minimum requirement on data normality. Based on these reasons, this study used PLS analysis technique to assess the measurement and the structural model in this study.

Results

The result of the demographic analysis revealed that 50.5% of the respondents are from the electrical, electronics, and computing sector (50.5%) which represents the largest proportion of the respondents' companies. The majority of the respondents are environmental, health and safety manager (50.5%), mainly from the multinational companies (45.6%), and working in companies with more than 251 full-time employees. This study used Smart PLS 2.0 M3 by Ringle *et al.* (2005) to estimate the parameters of the models and to maximize the variance in the firm performance that was explained by sustainable environmental manufacturing practices (SEMP). Hence, non-parametric method with 5000 bootstrapped sample was

used to estimate the standard errors (Chin 1998; Tenenhaus *et al.*, 2005; Wetzel *et al.*, 2009).

Assessment of the Measurement Model

Item Loadings, Average Variance Extracted and Composite Reliability

This study assessed the measurement model through the convergent validity, which indicates the degree to which several items measuring a certain concept agreed. The loadings, average variance extracted (AVE), and the composite reliability (CR) was assessed for the achievement of convergent validity. The result of the statistical analysis indicates a good item loading above the 0.5 recommended threshold by Hair *et al.* (2013). Relating to the composite reliability, the result shows high internal consistency results, ranging between 0.906 and 0.924. These values are above the threshold value 0.7 suggested by Hair *et al.* (2013). In addition, the AVE, which indicates the amount of the extracted variance by the latent constructs revealed values that ranges between 0.548 and 0.708, which are greater than the recommended threshold of 0.5 (Hair *et al.,* 2013). Hence, the result of the items loading, composite reliability and the AVE all exceeded the threshold values and therefore indicate the achievement of convergent validity.

Discriminant Validity of the Constructs

Unlike the convergent validity, the discriminant validity relates to the uniqueness of a construct. It indicates if the unique concept of the construct is represented by another construct of the model (Hair *et al.,* 2013). This study evaluated the discriminant validity by using the Fornel-Larcker criterion. This is done by comparing the square root of the average variance extracted values with the correlation values of each latent variable in the model (Fornell & Larcker, 1981). The correlation matrix along the diagonal represents the coefficient of AVE. To indicate the achievement of the discriminant validity, the values of each construct's AVE must be greater than its highest correlation with any other construct within the model (Hair *et al.*, 2013). Table 2 presents the result of the discriminant validity of the study.

Table 1: The convergence validity, AVE and reliability analysis

Constructs	Items Description	Loadings	AVE	CR
Environmental Performance	• Reduced carbon emission	0.783	0.668	0.909
	• Reduced waste wate	0.862		
	• Reduced solid wastes	0.821		
	• Decreased the consumption of hazardous material	0.842		
	• Decreased the frequency of environmental accidents	0.775		
Financial Performance	• Increase in return on investment	0.862	0.708	0.924
	• Increase in operating profit	0.805		
	• Increase in cash flow	0.857		
	• Increase in turnover rate	0.804		
	• Increase in market share	0.878		
Operational Performance	• Improvement in production quality	0.788	0.635	0.913
	• Lead time reduction	0.759		
	• Improvement in the development of better product	0.845		
	• Reduction in production waste	0.786		
	• Reduction in rejection rate of products	0.795		
	• Increase in customer satisfaction	0.806		
Sustainable Environmental Manufacturing Practices	• Provides periodic elaboration of environmental reports	0.725	0.548	0.906
	• Trains employees on environmental issues	0.767		
	• Considers environmental issues in selecting production process	0.761		
	• Chooses suppliers based on environmental issues	0.707		
	• Prevents pollution from the start of production process	0.809		
	• Prevents wastes from the start of production process	0.705		
	• Prevents air emission from the start of production process	0.733		
	• Reduces energy use by better maintenance procedure	0.710		

Note: Composite reliability (CR) = Square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the error variances)}. Average variances extracted (AVE) = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}

Table 2: Discriminant validity

Constructs	EP	FP	OP	SEMP
EP	**0.817**			
FP	0.361	**0.842**		
OP	0.511	0.666	**0.797**	
SEMP	0.421	0.283	0.360	**0.740**

Note: Values in the diagonals represent the squared root of average variance extracted while the other entries (off diagonals) represent the variable correlations.

Table 3: Results for the direct hypotheses

Hypotheses	Path coefficient	Beta	Std. Error	T-Value	Decision
H1	**SEMP -> FP**	0.095	0.133	0.715	*Not Supported*
H2	SEMP -> OP	**0.040**	0.115	0.346	*Not Supported*
H3	SEMP -> EP	0.264*	**0.113**	**2.336**	*Supported*

Assessment of Structural Model

The PLS path analysis was assessed through the structural model to evaluate the hypothesized relationship among the constructs of the study. The result of the standard path coefficients (β), standard error, t-value, and the decision taken on the hypothesized relationships are shown in Table 3. Among the three hypotheses formulated, the study found a significant relationship between SEMP and environmental practices (EP) (β = 0.264, t = 2.336, P< 0.10). The other two relationships between: (1) SEMP and financial performance (FP) (β = 0.95, t = 0.715, P < 0.10); and (2) SEMP and operational performance (OP) (β = 0.040, t = 0.346, P < 0.10) do not reveal evidences of significant relationships.

Discussion

The results obtained in this study do not support Hypotheses 1 and 2 in which sustainable environmental manufacturing practices were said to have a positive influence on financial performance and operational performance, respectively. Although, the findings show that SEMP has a positive influence on financial and operational performance, but the relationships are not significant. This finding is in contrary to the study of Lopez-Gamero *et al.* (2009); Ameer & Othman (2011) and Lai & Wong (2012). The non-significant relationship could be plausibly explained by the stage of implementation of sustainable environmental manufacturing practices in Malaysia. Omar and Samuel (2011) revealed that manufacturing firms in Malaysia irrespective of their ownership still regard sustainable manufacturing practices (SEMP) as an ethical behaviour. Necessary facilities for sustainable manufacturing practices were put in place only as a reaction to the pressure from high environmental regulation without consideration of sustainable manufacturing practices as a strategy that can enhance better financial and operational performance (Molina-Azorin *et al.,* 2009).

According to Jabbour and Santos (2006), certain objectives of the company are incorporated into the environmental management practices at this stage where sustainable environmental manufacturing practice is regarded as ethical behaviour. Even though, the variables of environmental practices might have been incorporated into certain aspects of production processes of the firms, they are yet to be utilized as a strategic factor of the entire firm (Molina-Azorin *et al.,* 2009).

Furthermore, the findings of Nishitami *et al.* (2013) also support the insignificant relationship between sustainable environmental manufacturing practice and financial performance. The relationship between environmental practices and financial performance is significant among the firms that voluntarily implement sustainable environmental manufacturing practices. Firms that implement environmental practices as a reaction to mandatory pressure from regulation is likely to experience improvement only in the environmental performance, while improvement in the financial and operational performance is experienced in a voluntary environmental initiative.

Environmental performance refers to the achievement of a certain level of environmental objectives by manufacturing firms in its environmental practices (Sharma & Vrendenburg, 1998; Sarkis, 2003). The third hypothesis posited a positive influence of sustainable environmental manufacturing practices on environmental performance. Expectedly, the result shows a significant relationship, similar to the findings of Lai and

Wong (2012); Zhu and Sarkis (2004). This findings implies that improvement in sustainable environmental manufacturing practices of firms enhances the achievements of environmental objectives such as reduced energy consumed by firms, carbon emission reduction, degradation of environment from the operations of manufacturing firms. As such, the more firms are committed to sustainable environmental manufacturing practices, the better will be their achievement of environmental performance.

Conclusion

This study has enhanced the understanding of the scenario and current level of implementation of SEMP in Malaysian manufacturing firms, as SEMP is yet to be considered as strategic resources that can enhance the achievement of competitive advantages and better performance. Therefore, this study will be beneficial to the manufacturing practitioners if more awareness could be created by the environmental policy makers to enlighten the manufacturing practitioners not only to consider sustainable environmental practices as ethical, but also as a strategic resource/factor in achieving better firm performance.

Manufacturing companies will benefit a win-win situation where an effort is made to maximize their returns by making progress towards the implementation of sustainable practices, as sustainable environmental practices have recently been linked with business strategy that enhance competitive advantage (Fowler & Hope, 2007). Though, evidence shows that firms will not voluntarily become sustainable, but corporate sustainable practices must rather erupt from self interest and the company's survival instinct (Lee & Ball, 2004) in order to achieve competitive advantage and better firm performance.

From the perspective of the natural resource based view, sustainable environmental practices may enhance firms competitive advantage by creating a shared long-term vision in firms (Hart, 1995). This long-term vision will not only be a source of competition in firms but it

will drive the development of competencies and technological advancement in firms. This may be regarded as strategic resources or factor that may enhance the survival chances and better performance of firms.

This study has been able to theoretically contribute to knowledge by conducting its investigation in a manufacturing industry in a developing country. This is so due to the fact that many previous studies were usually conducted in the developed nations (Arafat *et al.,* 2012; Rose *et al.,* 2011), considering the period it began and the numbers of available empirical studies conducted on the concept. The context of the current study (Malaysia) is relatively growing in the implementation of SEMP, as such, there is no doubt that literature concerning SEMP from this context is bound to be enriched. Therefore, much more about the theoretical relationship between SEMP and firm performance requires more explanation, especially in Malaysia (Arafat *et al.,* 2012) where only few or no similar studies have been conducted. It has added to the empirical investigation on sustainable environmental practices on firm performance in manufacturing industry.

This study has provided several implications both in theory and practical. Within the context of research, empirical evidences were provided on the effect of sustainable environmental manufacturing practices on firm performance. It has revealed and enhanced the understanding of the scenario of the current level of implementation of SEMP in Malaysian manufacturing firms, as SEMP is yet to be considered as strategic resources that can enhance the achievement of competitive advantages and better performance. Thus, the study has also suggested that environmental policy makers should create more awareness so to enhance manufacturing practitioners consider SEMP as not only ethical, but also as a strategic resource in achieving competitive advantage and better firm performance. This will create a win-win situation in manufacturing firms to maximize their returns by making progress

towards the implementation of sustainable environmental practices.

This study was conducted in a cross-sectional design in which data were gathered at a point in time. However, the benefits of sustainable environmental manufacturing practices can be realized in a long term rather than short term. Therefore, studying the phenomena of sustainable environmental manufacturing practices in more than one point in time (longitudinal study) is required. In addition, it is important to note that this study selected its sample from the manufacturing companies in a developing country (Malaysia). Although, these industries have been selected and used by many past studies, however, it is possible that the generalization of the result may not be applicable in a developed country or any developing country with different economic and environmental regulation from the context of this study. Therefore, future researchers are encouraged to conduct a similar study for comparison of results across countries.

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