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The Relationship between Sustainable Manufacturing Practice and Environmental Performance in Malaysian Automotive SMEs

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Abstract
This exploratory study seeks to determine the relationship between sustainable manufacturing practice (SMP), and environmental performance (EP) in Malaysian automotive industry. An attempt has been made in this paper to provide an overview of the available SMP and EP literature by classifying, and then critically reviewing the material to develop a framework for SMP and EP and suggest future research directions. This also includes model and three performance measure for SMP and EP measure. A summary of research findings and conclusions are reported at the end of the research view.
Keywords: Sustainable Manufacturing Practice, Environment Performance, SMEs

Introduction

Globalization in the Malaysian automotive industry moves fastest in early 1960's when the Malaysian government formed a policy to encourage an integrated to strengthen its industrial base and reduce its dependency on the agricultural sector (Habidin et al., 2015a). Under this policy, two national car projects namely Perusahaan Otomobil Nasional Berhad (PROTON) (founded in 1983) and Perusahaan Otomobil Kedua (PERODUA) (founded in 1994) have conquered the automotive industry commanding by 29% respectively of the local market share for the year ended March 2011. For the long-term mission, Malaysian automotive industry needs to boost the industrialization process to reach the status of a developed nation by year 2020. According to fact and figures by Malaysian-German Chamber of Commerce and Industry (MGCC) (2012), Malaysian automotive industry ranked the top 20 in the world in performance aspect, and disposes of the largest passenger car market share in Association of Southeast Asian Nations (ASEAN) region.

Generally, all the vendors and manufacture sector comes from SMEs. SMEs in various agencies define their criteria are usually based on annual sales, number of full-time employees

or shareholders' funds as a benchmark. Furthermore, the existing definition is more focused on SMEs in the manufacturing sector. Generally, SMEs defined as, medium business is categorized as a business in which the employee does not exceed 500 and not less than 51 people. While small businesses are comprised of 1-50 employees.

Environmental issues in business stick out as critical issues in business environment. This issue has been neglected by the company as the issues of profit come first. In reality, the greatest experience with environmental management tools has been in business, and especially in industry. Environmental management tools have been most often applied to manufacturing industries and tangible products (Conding et al., 2012; Conding et al., 2013). Due to the rise in these issues, the awareness of SMP has become an importance element to manufacturing industry. The number of researchers has attempted to refine this broad array of SMP into framework. Similarly, to support the continuous growth and expansion of manufacturing industry, SMP is the best approach (Yuan et al., 2012). For this purpose, Jayal et al. (2010) suggested a detail view of spanning on product, manufacturing processes and supply chain including the manufacturing systems across multiple product life-cycles. In Malaysian business environment, in order to improve sustainability scoring methods for SMP, PROTON for example use the products and processes, predictive models and optimization technique (Annual Report PROTON, 2011).

However, in this research, we are going to search and discuss about the relationship between the SMP and the EP in Malaysian automotive industry among SMEs company. Therefore, it is hoped that the integration between SMP and EP can contribute to the automotive industry in order to increase the sustainable implementation for this industry.

Literature Review

Overview of Malaysian Automotive Industry

Strategically located in the centre of Association of Southeast Asian Nations (ASEAN), Malaysia offers vast opportunities for global automotive and component manufacturers in order to set up manufacturing and distribution operations. Evidence showed that Malaysia has been attracted global automotive companies and international component manufacturers in order to launch their product in this country and meet highest consumer demand (MGCC, 2012). However, Malaysian government should also regulate the entry of foreign products in order to ensure the local automotive performance can survive in local and global market. Thus, a regulatory structure practice was gazetted to protect and control the automotive manufacturing activity.

For this reason, the ASEAN Free Trade Area (AFTA) and the National Automotive Policy (NAP) were announced as industry protections to support local automotive industry. Both AFTA and NAP have set up the main goal on the well-being of the Malaysian automotive industry in terms of competitiveness and industry expansion.

Thus, to face many challenges in the automotive environment, these policies could bring many advantages for local automotive industry. On the order word, various efforts have been made by the Malaysian government in an attempt to establish the Malaysian automotive industry, directly and sub industry, indirectly.

Sustainable Manufacturing Practise (SMP)

Due to awareness among the company about initiative program, many companies take an intention to apply sustainable initiative program in their company. The researcher make this issues as one of their subject research project and many documents related to them has been published. Indeed, according to Prahalad & Hammond, (2002); Szekely & Knirsch, (2005); Jayal et al. (2010); Gunasekaran & Spalanzani, (2011); Zubir et al., (2012); and Habidin et al., (2013) the issues of sustainability SMP has become a big and critical issues in impulsive business development.

Moreover, all the companies in this world are eager to implement SMP in term of competitive advantages (Presterious et al., 2003), customer relationship management (CRM) and the quality of product (Szekely & Knirsh, 2005), and continuous growth (Yuan et al., 2012).

Although this concept of sustainability has been widely spread and accepted in this area of business and an important feature of human activities, there is little guidance about it implementation. In the past, sustainable is only related to the environment. However, in current literature, sustainable was defined with three sectors; environment, social and economy (Figure 1) sometimes the technology come after become fourth (Baud, 2008).

Manufacturing Process (MP)

According to Porter Five Forces (1979), the organization should make any changes in their manufacturing strategies. Nowadays, new business model has become common as the born of new models are fastest. The organization need to take a fast action by creating the strongest strategies, or the new and rare strategies to solve the problem and maintain the quality (Habidin et al., 2012a). SMP can be implement by doing the core aspect, the early consideration of MP (Giachetti, 1998) in the term of efficiency of resource, management control, and the quality of product (Rahimifard & Clegg, 2007; Pernot & Roodhooft, 2008; Millar & Russell, 2011) in the early consideration while doing MP can lead the positive performance.

Supply chain management (SCM)

SCM teamwork will be seen as any kind of joint, interconnected effort between two positions in a SCM to achieve a common goal. The results showed that the organization should synchronize ordering and production cycle and avoid sub-optimization through the integration of activities along the supply chain, since organization cannot work independently; they must together with other organization in the supply chain to achieve their main objectives (Elkins et al., 2004; Pierreval et al., 2007; Kim & McCann, 2008; Olugu & Wong, 2012). Many articles from the past research argue about SCM provides a strategic link between the entire factor in business.

Social Responsibility (SR)

SR practice refers to something that organization should take an attention in the business society. This practice review as important part for socio-economic and environmental problem and suggest the best way for the future of sustainable (McWilliams & Siegel, 2001; Iamandi, 2007; Habidin et al., 2012b; Fuzi et al., 2013; Fuzi et al., 2015; Fuzi et al., 2016). Doctor (2007) and Shinkle and Spencer (2012), SR positively give an influence in organizational performance in

automotive industry and several industry (Shank et al., 2005). In this research, SR was explored based on the requirement of the research.

Environmental management (EM)

Nowadays, many practitioners highlighted the EM as an important element in business strategy. Singh et al. (2000), for example, addressed the important role of environmental dimension in product and MP. Singh et al. (2000) have found the positive integration between environmental process planning procedure and environmental impact in automotive industry. Another research by Evan et al. (2001) has demonstrated on how close cooperation between the producer and other factors can deliver environmental performance improvement. Normally, waste reduction in manufacturing contributes to EM (Simpson & Power, 2005).

Environmental Performance (EP

Environmental performance is very important to the company because it relates to environmental protection and readiness to support environmentally friendly products (Gjolberg, 2011; Habidin et al., 2015b; Habidin et al., 2015c). In relation to that, companies need to follow environmental regulations specified to improve the competitive aspect. Meanwhile, Sridhar (2011) pointed out that companies need to implement carbon emission reduction to improve their environmental performance. Thus, organizations which are practicing and nurturing green program and environmental stewardship such as green building design, increase green operations, wastage reduction, and enhance operational efficiency, provide benefits to the company in Malaysian automotive industry.

Methodology

Research Design

In order to understand the real world of automotive performance through quality initiatives, a structured survey was conducted in automotive manufacturing vendor. The questionnaire was developed and formatted in such a way to get the information and feedback with regards to management perception and practice on SMP and EP, both of the quality initiatives, how the implementation was carried out, the advantages and the returns as well as the factors that contribute to the success of SMP and EP in Malaysian automotive. The research hypothesis was conducted to clarify the relationship among the variables. At the end, the sustainable performance improvement model will be developing as a guideline to this industry.

Population and Sampling of Study

This research used a quantitative survey in the Malaysian automotive industry. Population of this research comprised on Malaysian automotive industry and samples were selected from the list of Proton Vendor Association (PVA) and Kelab Vendor Perodua (KVP). Both of suppliers consist of electrical, electronic, metal, plastic, rubber, and other automotive part.

Respondents' position such as Executive Manager, Director of Operations/Manufacturing or the person with the equivalent position in the organization was

selected. The questionnaire would be mailed to the person who have the knowledge, who are qualified, who have the more experience about SMP and SP of the company.

Statistical Analysis

In order to answer the research questions of this study, the data were analysed using SPSS Statistics 21.0 software. The data were analysed using correlation analysis and regression analyses. Correlation analysis was conducted to answer the objective of the study which is to investigate the relationship between SMP and EP. This analysis helps to trace the mutual influence of variables. Correlation and regression analysis was used in order to find the relationship between SMP and EP. The result of this analysis represents the best prediction of a dependent variable from several independent variables. Generally, the regression model for this study is summarized as follows:

$$EP = \beta 0 + \beta 1MP + \beta 2SCM + \beta 3SR + \beta 4EM + \varepsilon$$

EP = Environmental Performances
MP = Manufacturing Process
SCM = Supply Chain Management
SR = Social Responsibility
EM = Environment Management

F value is used to test whether the regression model could statistically explain significantly the variance in the independent variables.

A Propose Research Model

The research model aims to analyse the relationship between SMP and EP for Malaysian automotive industry. This model is called mediating model as presented in Figure 1.

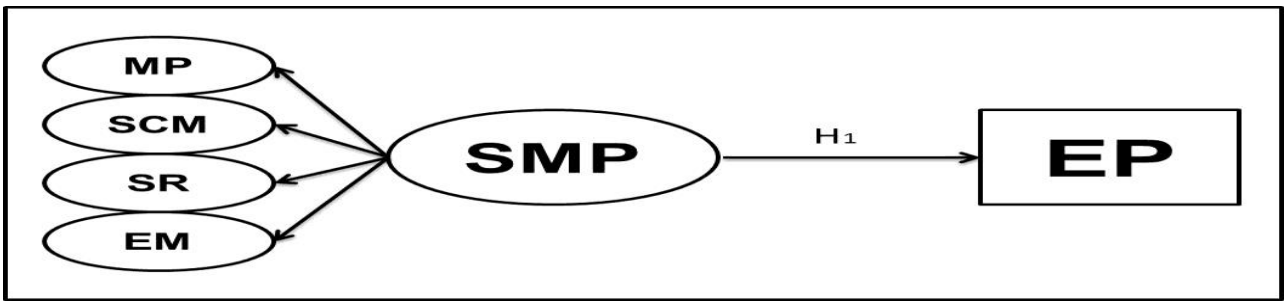

Figure 1. The proposed mediating research model

***Notes:**

SMP = Sustainable Manufacturing Practice
MP = Manufacturing Process
SCM = Supply Chain Management
SR = Social Responsibility
EM = Environment Management

EP = Environmental Performance

Research Hypothesis

H_1 : There is a positive relationship between the implementation of MP and EP in Malaysian automotive industry;

H_2 : There is a positive relationship between the implementation of SCM and EP in Malaysian automotive industry;

H_3 : There is a positive relationship between the implementation of SR and EP in Malaysian automotive industry; and

H_4 : There is a positive relationship between the implementation of EM and EP in Malaysian automotive industry.

Analysis and Discussion

Respondent Profile Descriptive Statistic

The first aspect investigated general background of respondents, including the number of years in business, type of product manufactured, number of employees, and current position in the company classification.

Table 1
The profile of the respondent (n = 80)

Constructs/measures	Frequency	Percentage
The number of year in business		
Less than 10 years	78	97.5
10 to 20 years	2	2.5
More than 20 years	0	0
Types of product manufactured[1]		
Metal	23	28.8
Plastic	38	47.5
Rubber	23	28.75
Engine/Transmission	15	18.75
Electric/electronic	21	26.25
Others	6	7.5
Number of employee		
Less than 50	75	93.75
Between 50 to 150	5	6.25
Current position		
Senior management	51	63.75
Middle management	25	31.25
Others	1	1.25

[1]Note: Some companies have more than one product

Exploratory Factor Analysis (EFA)

The next step in the analysis involves factors analysis. This section explains the results of Explanatory Factor Analysis (EFA). The EFA applied as the primary component analysis was used for extraction method. Varimax with Kaiser Normalisation was adopted before factor rotation, and at once it preserved the factors with eigenvalue of one or greater. This procedure was chosen to eliminate error variance as suggested by Tinsley and Tinsley (1987). In this study, EFA was conducted in two separate variables. Perform EFA to determine the underlying details (items) of SMP constructs.

EFA on SMP Constructs

EFA with varimax rotation of 15 items of SMP was done on random sample (n=80) of Malaysian automotive companies to determine the basic detail of each SMP constructs namely: MP, SCM, SR, and EM. Kaiser-Meyer-Olkin (KMO) measurement showed the sampling adequacy as 0.700 which was equal to 0.7 indicating that it was a suitable for principal component analysis. Similarly, Bartlett's test of sphericity was significant at ($p < 0.001$) indicating sufficient correlation among items to proceed with analysis as shown in Table 2.

Table 2
KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.700
Bartlett's Test of Sphericity	Approx. Chi-Square	496.259
	df	136
	Sig.	.000

Initial Solution Results

Initial solution results estimate variance in every variables caused by all components (DeCoster, 2004). Seven factors in initial solution had larger eigenvalues from unity as described in Table 3. This four factors contributed 62.178% from the total variance and sufficient for further analysis which requires at least 50% (Zakuan, 2009). This shows that four latent influences are associated. Meanwhile, the last column (cumulative percentage) indicated that the variance explained by extraction solution was also 62.178%, similar to the initial solution. Therefore, there is no change explained by initial solution lost because of latent factors that reflects the method of production in SMP.

Table 3
Total Variance Explained for SMP items

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.358	19.751	19.751	3.358	19.751	19.751	3.340	19.645	19.645
2	2.676	15.742	35.492	2.676	15.742	35.492	2.561	15.064	34.709
3	2.415	14.208	49.700	2.415	14.208	49.700	2.360	13.884	48.593
4	2.121	12.477	62.178	2.121	12.477	62.178	2.309	13.585	62.178

Rotated Component Matrix Results

In EFA, discriminant validity is only shown if the item loading is high towards related factor when compared to other factors. At least, 0.4 loads for each item on respective factor are considered sufficient for the factor (Hatcher, 1994; Fullerton & Wempe, 2009). However, a minimum of 0.5 fits cross-load items to various factors which are considered as sufficient (Ngai et al. 2004).

Matrix assists the researcher to identify items that correlate the highest to one factor and on lowest remaining factor. In this study, four factors for SMP constructs were compared to the original constructs from questionnaire. It consist of MP (MP1 – MP10), SCM (SCM1 – SCM3), SR (SR1 – SR3), and EM (EM1 - EM4). There are no item deleted.

Correlation

The Relationship between SMP and EP in Malaysian Automotive Industry

To determine the association of the independent variables and dependent variables; and test the hypotheses, the Pearson Product Moment Correlation Coefficients test was carried out. Table 4 represents the Pearson (r) correlation coefficient among the independent variables of the study. The result of the correlation reveals that the variables are statistically significant. The correlation coefficients range from 0.35 to 0.76 at $p < 0.01$. All the variables are correlated and statistically significant.

Table 4
Pearson Product Moment Correlation Coefficient (n=80)

Variable	MP	SCM	SR	EM	EN
MP	1	0.758(**)	0.624(**)	0.475(**)	0.412(**)
SCM		1	0.664(**)	0.528(**)	0.601(**)
SR			1	0.365(**)	0.415(**)
EM				1	0.345(**)
EN					1

**Correlation is significant at the 0.01 level (2-tailed)

The hypotheses tested in order to determine the above relationship in as follows:

H_1: *There is a positive relationship between the implementation of MP and EP in Malaysian automotive industry.*

To test this hypothesis, the Pearson product-moment linear correlation was applied. The correlation coefficient was $r = 0.41$, at $p < 0.01$. Thus, there is a significant positive association between the implementation of MP and EP in Malaysian automotive industry.

H_2: *There is a positive relationship between the implementation of SCM and EP in Malaysian automotive industry.*

The result shows that the correlation coefficient was $r = 0.60$, at $p < 0.01$, which seems to indicate there is a significant relationship between the implementation of SCM and EP. Thus, the result suggests that the companies with high levels of the implementation supply chain management better environmental performances.

H_3: There is a positive relationship between the implementation of SR and RP in Malaysian automotive industry.

The value of $r = 0.42$ at $p < 0.01$. The result revealed that there is a significant relationship between the implementation social responsibility and environmental performance in Malaysian automotive industry.

H_4: There is a positive relationship between the implementation of EM and EP in Malaysian automotive industry.

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The correlation was found to be r = 0.35 at p < 0.01. The result revealed that there is a significant relationship between the implementation environment management and environmental performance in Malaysian automotive industry.

Regression Analysis

The objective of this section is to determine the aggregate effect of the independent variables and EP Malaysian automotive industry. The formulated hypotheses are following:

H: The implementation of SMP constructs are significantly and positively related to the perceived environmental performances in Malaysian automotive industry.

In testing the hypotheses, multiple regression analysis was employed. Based on this method, a regression model was developed in determining the relationship of the variables understudied. The model is as follows:

EP = β0 + β1MP + β2SCM + β3SR + β4EM + ε

Where,
EP = Environmental Performances
MP = Manufacturing Process
SCM = Supply Chain Management
SR = Social Responsibility
EM = Environment Management
= constant, and
= standard error

Table 5
Multiple Regression Result for Independent Variables and Dependent Variables

R	R^2	**Adjusted R^2**	**Std. Error of the Estimate**	**F**	**Sig. F**
0.706	0.469	0.433	0.366	14.785	0.000

Table 6
Multiple Regression Result for Independent Variables and Dependent Variables

Variable	**Unstandardized Coefficients**		**Standardized Coefficient**	**t**	**Sig**
	B	**Std. Error**	**Beta**		
constant	2.557	0.531		4.814	0.000

Variable	Unstandardized	Coefficients	Standardized Coefficient	t	Sig
MP	-0.071	0.129	-0.079	-0.550	0.584
SCM	-0.669	0.141	0.713	-0.213	0.000
SR	-0.070	0.112	-0.079	-0.627	0.533
EM	0.712	0.214	0.613	4.752	0.000

Level of Significance: a) $p < 0.01$

The result of multiple regression analysis indicates that the multiple regression coefficient, R = 0.706 with R2 = 0.469, signifies that 46.9 % of the variation in the EP was statistically explained or accounted for the regression equation.

The R2 was statistically significant, with F=14.785 at $p < 0.0001$. Thus, the general expression in the form of the regression equation can be stated as follows:

EP = 2.557 + (-0.071) MP + (-0.669) SCM + (-0.070) SR + (0.712) EM + 0.531

The result of the multiple regression analysis indicated by the value of R2 and p suggested that there is a strong and significant relationship to support the hypotheses that are the independent can significantly explain the variations in the dependent variable. However, the variable, working area impact was not statistically significant.

Conclusion

Due to the lack of studies on above problems in this country, attempt to made to on SMP and EP measures in Malaysian automotive industry. Theoretically, this study focuses on review prior literature on same problem in Malaysia. In relation to that, the purposes of the future study are:

1. To develop research model of SMP and EP measure for Malaysian automotive industry
2. To research the effect of SMP and EP for Malaysian automotive industry
3. To identify the SMP and EP measures for Malaysian automotive industry.

Based on this long term recommendation a survey needs to be conducted to test survey's hypotheses. It is hoped that the important facts addressed in this paper will be a start-up for managers and researcher to investigate the SMP and EP in Malaysian automotive industry with better awareness.

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