[MAN 22] THE IMPACT OF GREEN MANUFACTURING ON ENVIRONMENTAL SUSTAINABILITY AMONG SMES IN MALAYSIAN MANUFACTURING SECTOR

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ABSTRACT

The aim of this paper is to determine the impact of green manufacturing on environmental sustainability among small and medium enterprises (SMEs) in Malaysian manufacturing sector. In specific, this study examines the level of green manufacturing implementation as well as the impact of this green practice on environmental sustainability among SMEs in manufacturing sector. Green manufacturing are measured through two components, namely eco-efficiency and cleaner production. This study was carried out based on a quantitative approach. A set of questionnaire was distributed to each of the targeted respondent which is the top level management. IBM Statistical Package for Social Sciences version 22 software (SPSS 22) was used to analyze the data from the study. In general, findings in this study have proven that the adoption of green manufacturing lead to improve environmental sustainability. However, in-depth investigation found that cleaner production is the single practice of green manufacturing that would improve environmental sustainability. Beside contribute to enhance body of knowledge in the field of sustainability and sustainable manufacturing, this study is valuable in promoting the importance of green manufacturing practice to preserve the environment sustainability among SMEs in manufacturing sector.

Keywords: *green manufacturing, small and medium enterprises (SMEs), environmental sustainability, manufacturing sector*

INTRODUCTION

Green manufacturing is a concept which reflect the new manufacturing paradigm that implement green strategies and techniques for an organization to become more efficient. Implementing the standards of green, green manufacturing strategies aim for achieving almost zero waste and pollution in the process of generating input and productive process. Prevent or at least reduce the amount of pollution relating to the raw materials consumption, energy usage and solid waste, reusing products, ecofriendly energy products and apply leadership practices to employees are some of the initiatives in green manufacturing practices (Ghazilla et al., 2015).

Awareness of preserving the environment is growing among industrial sectors in Malaysia. According to Department of Statistics Malaysia (2015), emission of pollutants from industry sector to the atmosphere decreased from 113 900 tons in 2010 to 101 900 tons in 2014. It is a great challenge to improve environmental sustainability

as the consumption of natural resources, which are limited in use, continuously increase due to the intensive industrialization of a country. The central to this awareness is preserving the environment that must sustain humankind today and for generations in the future. Therefore, the need for finding substitution of natural resources and using environmental-friendly resources are crucial to enhance the quality of natural environment. This seem reasonable given towards the growth in population today.

Today, despite the challenging economic environment, small and medium enterprises (SMEs) remain a priority for the government of Malaysia. In 2015, SMEs remained resilient, growing by 6.1% compared to the overall economic growth of 5%. The encouraging performance was partly due to a series of proactive measures taken by the government to reduce the impact of the economic downturn. SME growth accelerated to increase their contribution to gross domestic product (GDP) to 41% and exports to 23% in 2020 (SME Annual Report, 2015). Considering the importance of SMEs in Malaysian economic, there is a need to study the implementation of green manufacturing among the manufacturing firms to achieve better environmental sustainability.

The growth of economic in SMEs particularly in manufacturing sector also impacted the demand on natural resources. This will have an impact on everyone because of environmental pollution will increase and continuous depletion of natural resources. A variety of factors can contribute to the environmental problems such as increasing demand of goods and services among SMEs, and lack of regulation with regard to the use of natural resources. Environmental damaged occurs at an alarming rate as there is an increasing trend of the number of world population, consumption of non-renewable resources, as well as generation of waste and pollution emitted to the environment (Yazdi & Shakouri, 2012). Manufacturing firms including SMEs should integrate environmental consideration into their strategic goals and implementing green strategies such as adopting green manufacturing practices in order to prevent or at least reduced the pace of environmental degradation.

Although the discussion of green strategies has been increased in recent years, only a small number of studies that focus on the empirical study on the impact of green manufacturing on environmental sustainability in SMEs, particularly in certain countries. Most of these studies rely on conceptual review as well as merely focus on large companies. In order to fill this gap, this paper aims to focus on green manufacturing and environmental sustainability in the context of SMEs in the manufacturing sector. In particular, there are two objectives of this study:
1) To identify the level of environmental sustainability and green manufacturing practices among SMEs in manufacturing sector.
2) To determine the impact of green manufacturing on environmental sustainability among SMEs in manufacturing sector.

LITERATURE REVIEW

Sustainability
There are several definitions of the phrase "sustainability" in the past literature. The definition of sustainability by the UN Commission on Economic Development seems to be accepted and mostly used in the literature. United Nations (1987) defines

sustainability as meeting the needs of the present without compromising the usability for the coming generations to meet their own demand. Although, there are several researchers claimed that this definition was difficult to be achieved (e.g. Jabareen, 2008; Taylor, 2002), other researchers believe that it meets major aspects of sustainability in which can be translated into widespread application (e.g. Adams, 2001). As argued by Taylor (2002), it is difficult to determine the future because of the need for the coming generations may be different with humans now. Moreover, the requirement for developed countries and emerging countries is very different.

Although the United Nations definition of sustainability sparked controversy, it still has two fundamental issues, firstly economic growth against environmental pollution and the second is need to eradicate poverty in the community. There are three interrelated factors in the conceptual model by Barton (2000) and Du Plessis (2000) namely the economic, environment and society, as depicted in Figure 1. They are also called economy sustainability, environmental sustainability and social sustainability. The balance between these three factors are very important for the world to achieve sustainable development.
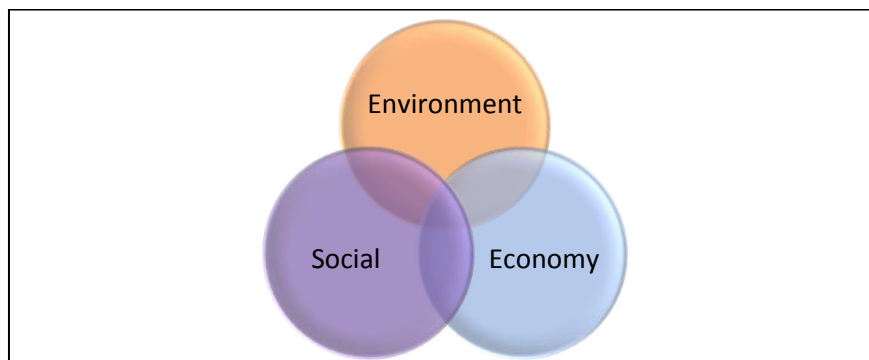

Figure 1
Interactions between the main sectors of sustainable development

Realizing sustainable development and the need to maintain a balance between the three factors has been the goals that need to be emphasized by the public, corporate organizations, government and so on around the world.

Environmental sustainability
Environmental sustainability relates to the ability to keep things or qualities that are valued in the physical environment. In the context of manufacturing firms, environmental sustainability refers to the ability of manufactures to reduce the level of resource usage, pollution emitted and waste generated (Hami et al., 2016). In order to improve environmental sustainability, firms are suggested to adopt green manufacturing practices.

Green manufacturing
Green manufacturing can be defined as the entire system, the economy and an integrated approach to the elimination and reduction of all waste streams associated with the design, manufacture, use or sale of materials and products (Hanfield et al., 1997). In order to achieve green manufacturing standards, potential safety issues, a threat to the health of employees and products, and environmental pollution should be zero during the production process (Gao et al., 2009). There are a variety of green

strategies and initiatives such as reduce the consumption of natural resources, use of recycled products or components, use of renewable resources, redesign production processes and products to eliminate the production of toxic substances, and protection and restoration of natural habitats livability and value to the environment (Sutton, 2004).This study operationalize green manufacturing into two practices namely cleaner production (CP) and eco-efficiency.

CP involves changing attitudes towards environmental management for developing an environment conducive to national policy. The concept of CP was introduced in 1989 by United Nations Environment Programme (UNEP). CP is a preventive environmental strategy which focuses on preventing pollution at source (i.e. in the product and manufacturing processes) instead of remove pollution after it was created. CP can be divided into three categories. First, the products can reduce the negative effects along the product life cycle. Second, the production process aimed at eliminating toxic of waste and energy. Third, service incorporating environmental concerns into designing and delivery services.

Business Council for Sustainable Development started to define the concept of eco-efficiency in 1992 as meet human needs in terms of quality goods and services that reduce the ecological impact and intensity of environmental resources in line with the capacity of the earth. Seven success factors for eco-efficiency specified by the WBCSD, which reduces the intensity of goods and services, reducing the energy intensity of goods and services, reduce the spread of toxic, increase recycled material, maximizing the use of renewable sources of imprisoned resistance and finally increase the intensity of services for goods and services.

Green manufacturing and environmental sustainability
The significant impact of green manufacturing on improving environmental sustainability have been recognized and reported in some previous studies. For example, studying the impact of green manufacturing on environment sustainability, Ranjit (2001) and Deif (2011) found that green manufacturing practices have a significant positive impact on environmental performance. While some researchers found the significant relationship between green manufacturing and environmental sustainability, there are several researchers who failed to prove the significant relationships between these two variables. For example, Bulent and Siben (2013) found that there is no significant relationship between green eco-product innovation and corporate environmental sustainability. Therefore, it is important to make further investigation to see whether there are interdependence relationship between green manufacturing and environmental sustainability.

Based on the above discussion, it is proposed that green manufacturing has significant impact on environmental sustainability, as depicted in Figure 2.
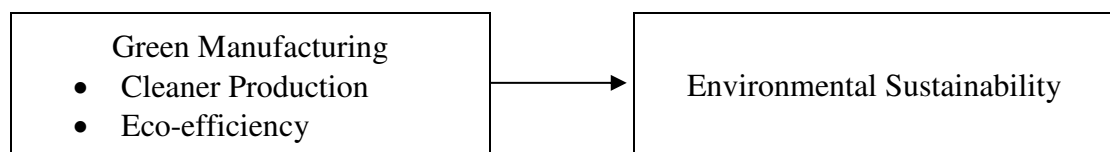
Green Manufacturing • Cleaner Production • Eco-efficiency	→	Environmental Sustainability

Figure 2
Research framework

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Deriving from the proposed research framework, the following hypotheses are developed.

H1 : Green manufacturing has a positive and significant impact on environment sustainability.

H1(a) : Cleaner production has a positive and significant impact on environment sustainability.

H1(b) : Eco-efficiency has a positive and significant impact on environment sustainability.

RESEARCH METHOD

Data collection and sample

The population of this study is SMEs in the manufacturing sector in Malaysia. Unit of analysis is individual manufacturing company. About 260 questionnaires were distributed to the targeted respondents through convenience sampling study. Each respondent represents one company. The targeted respondents for this survey are the top level management. After discarding one survey form for extreme outliers, the survey yielded 119 usable responses, or 46% response rate effectively.

Receiving responses from various SMEs in manufacturing sector, majority of organizations are from four industries, food and beverages products (21.8%), rubber and plastic products (10.9%), wood and wood products (10.1%) and electrical and electronic (9.2%). While the remaining 48% are from, machinery and equipment, paper products, leather and relate products, coke and refine petroleum products, fabricated metal products, printing and reproduction of recorded media, non-metallic mineral products, furniture, basic metal, textile and wearing apparel chemical and chemical products and pharmaceutical products. In total, about 11.8% of responding companies have ISO 14000 qualification.

Majority of the respondents (51.3%) are from small-sized while 29.4% and 19.3% are micro and medium organizations. In term of position in the firm, almost 40% of the respondent are CEO or Director (39.5%) while the remaining respondents are production or manufacturing manager, executive and others.

Measurement scale

A diverse range of measurement has been designed to measure green manufacturing and environmental sustainability. The range of scale used to measure both variables is from 1 which is "strongly disagree" to 5 "strongly agree". In this study, the initial questionnaire was adapted from Hami et al. (2016). In order to verify the reliability and the validity of the questionnaire, the pretest was conducted by a group of academicians which experts in the topic studied. Following the validation guidelines for measurement suggested by Sekaran (2003), the measurement scales used for the purpose of this study were tested for internal consistency reliability and construct validity.

Factor analysis was employed in this study to verify the validity of the measures. In order to get uni-dimensionality of each variable, one item of cleaner production and environmental sustainability respectively were deleted, as shown in Table 1. The remaining items of each variable were tested for interim consistency reliability by using Cronbach's alpha coefficient. This test was run to ascertain the consistency of

respondents' answers to all the items in a measure. Using the SPSS reliability analysis procedure, an internal consistency analysis was performed separately for the items of each variable. The closer the reliability coefficient to 1.0, the higher the internal reliability. Referring to the results in Table 1, all Cronbach's alpha values are greater than 0.800, indicating high internal consistency and therefore proving the reliabilities of variables.

Table 1
Validation results

Variables	No. of items	Item deleted	KMO	Cronbach's Alpha
Cleaner production	6	1	0.681	0.819
Eco-efficiency	6	-	0.809	0.864
Environment sustainability	7	1	0.829	0.880

Notes: KMO = Kaiser-Meyer-Olkin measure of sampling adequacy; $n = 119$

Data analysis technique
IBM Statistical Package for Social Sciences version 22 software (SPSS 22) was used to analyze the data in this study. Descriptive analysis was performed to fulfil the first objective in this study relating to the level of environmental sustainability and green manufacturing practices among SMEs in manufacturing sector. Meanwhile, Pearson correlation and regression analysis were adopted to test the proposed hypotheses which are reflected the second objective. Regression analysis was applied to test the causal relationship between green manufacturing and environment sustainability.

FINDINGS AND DISCUSSION

The mean and standard deviation of green manufacturing and environment sustainability are presented in Table 2.

Table 2
Descriptive results of green manufacturing and environment sustainability

Variables	Maximum	Minimum	Mean	Standard deviation
Cleaner production	5.00	1.00	3.8504	0.65054
Eco-efficiency	5.00	1.67	3.8179	0.71340
Environmental sustainability	5.00	2.00	4.0616	0.62356

The mean value of 3.8504 and 3.8179 indicate the moderate level of implementation of CP and eco-efficiency, respectively. Meanwhile, the level of SMEs' achievement on environment sustainability is slightly good, as indicated by the mean value of 4.0616. The results demonstrate that Malaysian SMEs manufacturers began to realize corporate responsibility and sustainability as critical issues in recent years for long term existence and thriving firms. However, they need to be exposed to the advantages of green manufacturing adoption in order to accelerate their efforts on being environmental friendly. While improving their profitability, SMEs could achieve better environmental sustainability by adopting green manufacturing. Green manufacturing not only have to

be implemented in the production department, but other departments or functions need to do so such as financial, purchasing, human resource and marketing.

Responding to the second objective of this study regarding to the impact of green manufacturing on environmental sustainability, correlation and regression analyses were performed. As shown in Table 3, each of the correlation tested in this study is found to be positive and significant at the 0.01 level. It indicates that there is a positive and significant relationship between cleaner production and environmental sustainability ($r = 0.439$, $p < 0.05$) as well as eco-efficiency and environmental sustainability ($r = 0.321$, $p < 0.05$). Since the correlation values (r) are 0.439 and 0.321, both green manufacturing practices have medium strength relationship with environmental sustainability as suggested by Cohen (1988), with cleaner production is stronger than eco-efficiency.

Table 3
Correlation results

		Cleaner production	Eco-efficiency
Environmental sustainability	Pearson Correlation	.439**	.321**
	Sig. (1-tailed)	.000	.000
	N	119	119

**. Correlation is significant at the 0.01 level (1-tailed).

Based on regression result shown in Table 4, environmental sustainability is significantly explained by the combination of the two practices of green manufacturing (i.e. cleaner production and eco-efficiency) as indicated by the significant F. Therefore hypothesis 1 (H1) is supported. R^2 value of 0.201 indicates that green manufacturing practices explain 20.1% of the variance of environmental sustainability. However, in-depth investigation of the individual impact of green manufacturing practice on environmental sustainability found that cleaner production is the single practice that would significantly improve environmental sustainability. There is no statistical evidence found to prove the significant impact of eco-efficiency on environmental sustainability. Therefore, the specific hypothesis of H1(a) is accepted while H1(b) is rejected.

Table 4
Regression result

Dependent variable	Independent variable	Sig. F	R^2	Beta	P
Environmental sustainability	Cleaner production	0.000	0.201	0.379	0.000
	Eco-efficiency			0.107	0.288

CONCLUSIONS

The objectives of this study are to determine the level of green manufacturing and environmental sustainability as well as to analyze the impact of green manufacturing on environment sustainability among SMEs in manufacturing sector. Green manufacturing can be divided into two practices namely cleaner production and eco-efficiency. In general, the results have shown that there is a moderate level of implementation of both practices among responding companies with the better level

recorded on cleaner production compared to eco-efficiency. Meanwhile, the level of SMEs' achievement on environment sustainability is slightly good. In addition, in reaching environment sustainability goal, the results have confirmed that green manufacturing would play a significant role. However, in-depth investigation found that only cleaner production has a significant impact on improving environmental sustainability. There is no significant impact of eco-efficiency on environmental sustainability.

This study is expected to increase the level of awareness of environment sustainability issues and promoting the implementation of cleaner production and eco-efficiency among SMEs in manufacturing sector. Through literature review, this research provides a better understanding of the elements of green manufacturing and environment sustainability. While the literature acknowledges the significant role of green manufacturing on achieving better environment sustainability, the present results discovers that SMEs are still not fully integrate both practices of green manufacturing into their operational business activities. This is because from the result, we can see eco-efficiency is not significant to the environmental sustainability. This may be due to several weaknesses of SMEs in term of financial, expertise, knowledge and others. The findings of the present study could be served as an additional source of reference in making decision and further actions related to the efforts on promoting environmental protection. In addition, the findings of this study can be useful for SME organizations that aspire to launch a sustainability program.

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