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Initial Study of Factors on Green Supply Chain Management, Green Supplier Strategy and Work System Performance

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Abstract: In implementing green supply chain initiatives, this paper aims to explore the level of green supplier, manufacturing efficiency, environmental behaviour and company activities. In addition, the relationship between environmental practices and consumer behaviours in manufacturing was also examined. Towards this, the data was collected among Malaysian manufacturing firms using questionnaire-based survey. From the results, it is showing that the manufacturing performance through the implementation of green supply chain management has a positive relationship to environmental action and customer activities.

Keywords: Green Supplier, Manufacturing Performance, Green Supply Chain

1. Introduction

The rapid growth of manufacturing industry has urged manufacturers to have a flexible supply chain management (SCM) system that able to integrate all the elements involved. By focusing on the environmental aspects, Green Supply Chain Management (GSCM) was introduced with the aim of bringing environmental aspects into Supply Chain Management (SCM), starting with product design and advancing through the procurement and selection of products, manufacturing processes, final product delivery and end-of - life management [1]. These evidently produce a positive impact on social, economic and environmental goals [2]. Recent studies had showed that the implementation of green aspects (green design, green manufacturing and green logistic) in SCM can facilitate the reduction of energy consumption, reuse of material, and the redefinition of operation and production processes [3],[4].

As suggested by Li and Huang [5], the performance of GSCM can be measured through the focus on environment, economy, and competency. Based on review, there are eight indicators can be used to measure the implementation performance of GSCM as tabulated in Table 1. All these indicators are useful in order to explore how Green Supplier affecting the aspect of environment, practices, achievement and performance of manufacturers in implementing GSCM. In green element, sustainable is the ability of earth's various systems including human cultural systems and economies to survive and adapt to changing environmental conditions [6].
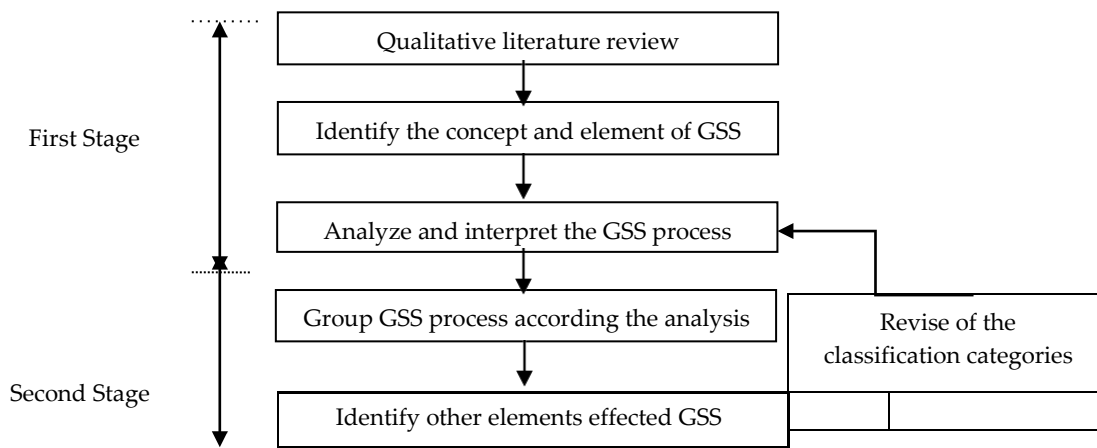
Table 1 - Indicators of Green Supplier

	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Awareness seminars for suppliers/ contractors	x		x	x	x	x	x	x	x	x
Guide suppliers to establish their own programs	x		x	x		x		x	x	x
Sharing experiences			x	x		x		x	x	x
Notify supplier on the benefits of cleaner production and technologies			x	x		x		x	x	x
Force supplier to take environmental actions	x	x	x		x		x			x
Select suppliers according to environmental criteria	x	x			x		x			x
Assist supplier to purchase pollution prevention and wastewater recycling equipment	x	x	x	x	x		x			x
Perform environmental performance audit on the suppliers		x	x	x	x		x	x	x	x

Notes: Author(s) : [9] Jabbour and Jabbour (2009); [10] Dubois and Pedersen (2002); [11] Bennett and Klug [2012]; [12] Simpson and Power (2005); [13] Sahu et al. (2014), [8] Lee (2008); [14] Genovese (2010); [15] Carr (2008); [16] Hwang and Min (2013); [17] Marksberry (2012)

This paper was structured according to the follow. Section 2 explains the study methodology; section 3 addresses the process analysis in conducting the supplier activities and the conclusion in section 4. At the end of the paper, some suggestions for future research conclude as well.

2. Research Methodology

The study started by identifying the relevant information importance of the study from the existing literature review. The systematic search for relevant information then served as a scientific approach in formulating the steps taken in the review process to ensure that in a controlled situation more rigorous information about the focus area can be done. In this paper the method of research was divided into two main parts as shown in Figure 1.

Fig. 1 - Research Method

The first stage of literature focused on the concepts and elements in Green Supplier Strategy (GSS). GSS is a criterion needs by supplier in GSCM. Groundwork of reviewing process done on literature initiatives in several focus areas to make sure it was covers in various industries. The reviewing process covers such as analytical methods, framework, findings, factors, and limitation. Next, this information was interpreted and used to identify the keys area in the interaction process of GSS.

In the second stage, the main criteria were then identified and extracted into several grouped by using factor analysis. The factor analysis was executed based on principal components analysis with the Varimax rotation at eigenvalues of discontinuity greater than 1. The Varimax rotation methods were chosen because it can reduce the number of complex variables and improve yield expectations. Next, mean scores are used to identify the significance elements that encourage to the success of GSCM implementation. As a result, all the criteria were extracted into four group, namely Strategic Environment Process (SEP), Work Responsiveness Practices (WRP), Manufacturing System Achievement (MSA) and Work System Performance (WSP).

3. Result and Discussion

In this study, analysis on the implementation of GSCM is based on four group of practices, namely Work Responsiveness Practice (WRP), Strategic Environment Practices (SEP) of GSCM, Manufacturing System Achievement (MSA) and Green Supplier Strategy (GSS). Studies by Rao [17] and [18] showed that the general overview of the GSCM implementation can be measured through any of three of these categories (WRP, SEP, MSA OR GSS). Initially, there are 13 elements extracted into WRP, followed by 21 elements in SEP, 16 elements in MSA and 8 elements in GSS. Therefore, supplier evaluation, which is an important phase in supply management, depends on assessing a wide range of quantitative and qualitative factors [19].

3.1 Green Supplier Strategy

Participation of suppliers in providing direct inputs to manufacturing companies has stepped up in recent years [7]. Manufacturers have increasingly seen suppliers supporting processes for improving customer quality (continuous improvement), working together in customer product development activities (early involvement of suppliers) and production inside customer production units (modular consortium). As in Table 2, Green Supplier Strategy consists of two factors. In first group, four GSS indicators (GSS 3, GSS 7, GSS 2 and GSS4) are group together with the factor loading ranging from 0.657 to 0.862, at highest variance with eigenvalues 3.967, and the cumulative percentage of the variance of 49.589. From the observation, supplier needs training and guiding from the manufacturer in the requirement needs in GSCM.

For the awareness, four GSS indicators (GSS 8, GSS 6, GSS 5 and GSS 1) were extracted into one factor with the factor loading ranging from 0.630 to 0.894, eigenvalues 1.319 and cumulative percentage of variance of 66.071. The criteria included holding awareness seminars for suppliers/contractors, guiding suppliers to establish their own environmental programs, bringing together suppliers in the same industry to share their knowledge, experience and problems, and notify suppliers about the benefits of cleaner production and technologies.

Table 2 - Factor Analysis of Green Supplier Strategy

Factor	Greening the Supplier	Communalities	Factor Loading	Eigen Value	Cumulative %
Guiding Supplier	Bringing together suppliers in the same industry to share their know how and problems (GSS 3)	0.755	0.862	3.967	49.589
	Arranging for funds to help suppliers to purchase equipment for pollution prevention, waste water recycling, etc.(GSS 7)	0.712	0.829		
	Guiding suppliers to establish their own environmental programs (GSS 2)	0.672	0.762		
	Informing suppliers about the benefits of cleaner production and technologies (GSS 4)	0.499	0.657		
Awareness	Sending in-house Manufacturers auditors to appraise environmental performance of suppliers (GSS 8)	0.815	0.894	1.319	66.071
	Choice of suppliers by environment Criteria (GSS 6)	0.643	0.795		
	Urging/pressuring suppliers to take environmental action (GSS 5)	0.614	0.709		
	Holding awareness seminars for suppliers/contractors (GSS 1)	0.575	0.630		

3.2 Work System Performance

Performance measurement is an important management mechanism and is highly effective in controlling and ensuring organizational performance in line with the objectives set [20]. It aims to create relevant information in order to strengthen the decision-making, overall performance and accountability [21]. Shaw et. al, [22] also found that it is suitable for evaluating the effectiveness of specific activities.

The total variance for these factors is 58.067%. As summarized in Table 3, all the items were extracted in one group at factor loading between 0.698 to 0.831, with the Cronbach's alpha value of 0.834. All indicators in WSP are closely related to performance of the manufacturing performance. Based on this similarity, it is reasonable to justify this factor known as Work System Performance (WSP).

Table 3 - Factor Analysis of Work System Performance

Factor	Performance of Manufacturing System	Communalities	Factor Loading	Eigen Value	Cumulative %
Work System Performance (WSP)	WSP 2	0.691	0.831	3.484	58.067
	WSP 1	0.625	0.791		
	WSP 5	0.615	0.784		
	WSP 3	0.536	0.732		
	WSP 4	0.535	0.731		
	WSP 6	0.482	0.698		

3.3 Strategic Environment Practices

The use of machinery or equipment, energy supply of electricity, water, and natural resources always considered in GSCM activities [23]. Qinghua et al., [24] found that these criteria are no limitations, however includes all activity in the supply chain management such as logistic, capacity, process flow and equipment, and other locations.

As observed from the factor analysis, twelve SEP indicators were constructed into three groups of factors, and loaded independently to each factor structured at high loading value ranging from 0.596 to 0.896 (see Table 4). In the first factor group, five SEP indicators (SEP 15, SEP 13, SEP14, SEP16 and SEP 19) are group with the factor loading ranging from 0.775 to 0.861, at the highest variance with eigenvalues 3.516, and the cumulative percentage of the variance of 27.046%.

Table 4 - Factor Analysis of Strategic Environment Practices

Factor	Environmental Actions	Communalities	Factor Loading	Eigen Values	Cumulative %
Recycling Commitment	Assists suppliers to establish their own EMS (SEP 15)	0.777	0.861	3.516	27.046
	Use of waste of other companies (SEP 13)	0.742	0.853		
	Use of alternative sources of energy (SEP 14)	0.799	0.851		
	Recovery of the Manufacturers end-of-life products (SEP 16)	0.693	0.784		
	Taking back packaging (SEP 19)	0.675	0.775		
Natural Usage	Optimization of processes to reduce solid wastes (SEP 7)	0.813	0.896	2.748	48.181
	Design considerations (SEP 6)	0.529	0.700		
	Use of cleaner technology processes to make savings (energy, water, wastes) (SEP 11)	0.588	0.627		
	Optimization of processes to reduce air emissions (SEP 9)	0.508	0.596		
Optimization of Usage	Substitution of environmental questionable materials (SEP 2)	0.820	0.893	2.511	67.497
	Environment-friendly raw materials (SEP 1)	0.723	0.777		
	Choice of suppliers by environmental criteria (SEP 3)	0.671	0.734		

3.4 Manufacturing System Achievement

The manufacturers that adopt GSCM practices will have better business and competitive performance, and are able to positively influence a Manufacturers' environmental performance, as well as support its competitive strategies [25]. As in Table 5, ten components were extracted into two groups. In the first group, there are four indicators (MSA 1, MSA 2, MSA 3 and MSA 5) with factor loading from 0.718 to 0.901 and eigenvalues 3.532. The first group was named as profits because the elements directly involved in profits gain by Manufacturers. The second group that involve six components (MSA 13, MSA 16, MSA 4, MSA 14 and MSA 9) with factor loading from 0.586 to 0.746 with eigenvalues 3.166. The second group names as reputation as it involves the names of the Manufacturers.

Table 5 - Factor Analysis of Manufacturing System Achievement

Factor	Benefits of GSCM	Communalities	Factor Loading	Eigen Value	Cumulative %
Profits	Increased efficiency (MSA 1)	0.841	0.901	3.532	35.320
	Quality improvement (MSA 2)	0.862	0.890		
	Productivity improvement (MSA 3)	0.841	0.855		
	Cost saving (MSA 5)	0.597	0.718		
Reputation	Social commitment (MSA 13)	0.556	0.746	3.166	66.979
	Improved corporate image (MSA 6)	0.755	0.741		
	Preserve environment (MSA 16)	0.578	0.726		
	New market opportunities (MSA 4)	0.729	0.707		
	Sales (MSA 14)	0.472	0.632		
	Recycling (MSA 9)	0.465	0.586		

3.5 Work Responsive Practices

The execution of GSCM drives the level of responsiveness in terms of employee commitment and excellence management system (training, management complaint, supplier management, non-conformity issues and etc.). Although there have several discussions on the successful factors can provide confirmation of the implementation of GSCM, but the methods and techniques are subject to the cost involve and the execution time.

As summarized in Table 6, the indicators of WRP 8, WRP 9, WRP 5, WRP 11, WRP 13 and WRP 12 are extracted below the first factor at loading value in between 0.514 to 0.785. This factor has the highest variation with the eigenvalues of 6.288 and the cumulative variation of 48.368%. Meanwhile, four indicators, i.e., WRP1, WRP 4, WRP 2 and WRP 10 have the loading factor ranging from 0.536 to 0.804 are group into the second group. The third group contains three indicators which is WRP3, WRP 6 and WRP 7 have the loading factor ranging from 0.713 to 0.867.

Table 6 - Factor Analysis of Work Responsive Practices

Factor	Quality and Customer Related	Communalities	Factor Loading	Eigen-Values	Cumulative %
Quality Control	Use of statistical process control (SPC) (WRP 8)	0.658	0.785	6.288	48.368
	Identification of courses for non-conformity (WRP 9)	0.768	0.764		
	Ensure training needs are identified and records of who has been trained in which topics (WRP 5)	0.672	0.760		
	Employee training / employee involvement (WRP 11)	0.769	0.735		
	Top management commitment (WRP 13)	0.516	0.550		
	Benchmarking (WRP 12)	0.482	0.514		
Process Management	Identification of customer needs/customer focus (WRP 1)	0.679	0.804	1.368	58.891
	Ensure identity of preferred suppliers and a system for advising them of what is expected to be supplied (WRP 4)	0.708	0.746		
	(Re) Defining production/operations procedures to ensure greater efficiency (WRP 2)	0.619	0.694		
	Ensure workers commitment (WRP 10)	0.604	0.536		
Evaluation Management	Ensuring that staff are issued correct versions of documentation needed to perform task (WRP 3)	0.824	0.867	1.119	67.497
	Ensure customer complaints are properly addressed (WRP 6)	0.797	0.818		
	Ensure minimization and commitment to remove non-conformities (WRP 7)	0.679	0.713		

4. Conclusion

Malaysian manufacturers' implementation of GSCM is more focused on the activities that related to the natural source uses. Based on the results, GSS levels are primarily influenced by GSCM 's level practices in manufacturing operations. Three variables, namely SEP, WRP and MBA, significantly contributed to the improvement of the WSP, the establishment of the Green Supplier Model. These findings can provide basic information in establishing the strategy and the actions needed to achieve high levels of green practices in the manufacturing firm.

Acknowledgement

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