

Available online at www.sciencedirect.com**ScienceDirect**

Procedia CIRP 26 (2015) 695 – 699

www.elsevier.com/locate/procedia

12th Global Conference on Sustainable Manufacturing

Green Supply Chain Management, Environmental Collaboration and Sustainability Performance

Thoo Ai Chin^{a,*}, Huam Hon Tat^b, Zuraidah Sulaiman^a^aUniversiti Teknologi Malaysia, Faculty of Management, Department of Business Administration, 81310 Skudai, Malaysia^bQuest International University Perak, Faculty of Business, Management and Social Sciences, 227, Plaza Teh Teng Seng (Level 2), Jalan Raja Permaisuri Bainun, 30250 Ipoh, Perak, Malaysia* Corresponding author. Tel.: +6-075-510-133; fax: +6-075-610-099. E-mail address: acthoo@utm.my

Abstract

The increased attention given to the topic of green supply chain management (GSCM) warrants the writing of this paper. The concept of GSCM is to integrate environmental thinking into supply chain management (SCM). As such, GSCM is important in influencing the total environment impact of any organizations involved in supply chain activities. More importantly, GSCM can contribute to sustainability performance enhancement. In this paper, we focus on the environmental collaboration, which has been seen as a key relational capability to facilitate the GSCM strategic formulation and execution. The purpose of this paper is two-fold: (i) review the extant literature on the relationship between GSCM, environmental collaboration and sustainability performance and (ii) propose a plausible conceptual model to elucidate the relationship between these three variables in the context of Malaysian manufacturing companies. Accordingly, such thought depends upon more detailed empirical research by using advanced structural equation modeling approaches. The research findings will be particularly important for manufacturing companies in developing environmental collaboration with their suppliers in order to achieve sustainability performance.

© 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of Assembly Technology and Factory Management/Technische Universität Berlin.

Keywords: Green supply chain management (GSCM), Environmental collaboration, Sustainability performance, Manufacturing

1. Introduction

Business activities can pose a significant threat to the environment in terms of carbon monoxide emissions, discarded packaging materials, scrapped toxic materials, traffic congestion and other forms of industrial pollution [1]. Green supply chain management (GSCM) is considered as an environmental innovation. The concept of GSCM is to integrate environmental thinking into supply chain management (SCM). GSCM aims to minimize or eliminate wastages including hazardous chemical, emissions, energy and solid waste along supply chain such as product design, material resourcing and selection, manufacturing process, delivery of final product and end-of-life management of the product [2] [3]. As such, GSCM plays a vital role in influencing the total environment impact of any firm involved

in supply chain activities and thus contributing to sustainability performance enhancement.

GSCM is evolved from SCM. As competition intensified in the 1990s, the increased awareness of green practices has triggered firms to act in an ethically and socially responsible manner in their supply chains [4]. In the beginning of 1995, GSCM has attracted considerable scholarly interest; GSCM received highest attention in 2010 [5]. With these practices in mind, firms develop environmental management strategies in response to the changes of environmental requirements and their impacts on supply chain operations [6].

A supply chain is a network consists of all parties involved (e.g. supplier, manufacturer, distributor, wholesaler, retailer, customer, etc.), directly or indirectly, in producing and delivery products or services to ultimate customers – both in upstream and downstream sides through physical distribution, flow of information and finances [7]. According to Chopra

and Meindl [8], a typical supply chain includes the following five stages: component/raw material suppliers, manufacturers, wholesalers/distributors, retailers and customers. These five stages are connected through flows of products, information and money. Managing a supply chain network is complex and difficult since the network involves various sub-systems, activities, relationships and operations [9]. SCM practices include a set of approaches and activities utilized by a firm to effectively integrate supply and demand for improving the management of its supply chain [10]. By adding a “green” component in the SCM practices, GSCM practices encompass a set of green activities in procurement, manufacturing, distribution and reverse logistics [11].

The main focus of SCM is to provide right product to the right customers at the right cost, right time, right quality, right form and right quantity [12]. In addition, the short-term strategic goal of SCM is to reduce cycle time and inventory and thus increasing productivity, whereas the long-term goal is to enhance profits through market share and customer satisfaction [13]. The benefits that can be derived from SCM have been long recognized in the SCM literature. For example, the quantified benefits of SCM include lower supply chain costs, overall productivity, inventory reduction, forecast accuracy, delivery performance, fulfilment cycle time and fill rates [14]. SCM delivers improvement up to 60 per cent, which ranges between 10 per cent and 60 per cent. Fulfilment cycle time records the highest improvement from 30 per cent to 60 per cent. In the context of small and medium firms, cost effective SCM is critical for its survival and growth as purchasing cost makes up the largest share in sales revenue – approximately 80 per cent [15]. The potential benefits of SCM include increased customer service and responsiveness, improved supply chain communication, risk reduction, reduced product development cycle time processes, reduction in duplication of inter-organisational processes, inventory reduction and improvement in electronic trading [16]. Koh et al. [17] found that the execution of SCM practices could deliver benefits in terms of reduced inventory level, reduced lead time in production, increased flexibility, forecasting accuracy, cost saving and accurate resource planning.

As the SCM practices become mature, governments along with firms and their supply chain partners are collaborating to reduce environment problems in order to reduce waste, energy and pollution, minimize environmental risks and improve community goodwill. The collaboration can promote mutual environmental learning [18]. Companies that implement GSCM practices benefitted from cost savings (conserving materials, reduced energy and water use), better public image and decreased environmental liability [1]. Poor environmental achievement can pose significant environmental impacts and result in monetary losses for the companies such as lower stock prices. According to Flammer [19], companies’ eco-friendly behavior is closely related to significant stock price increases, whereas firms with eco-harmful behavior face decreases in stock price. Therefore, firms are sensitive to environmental footprint may be able to attract resources from socially concerned investors.

An increasing concern and awareness among the general public for environmentally friendly business processes and

prevention of global warming can trigger firms to show remarkable commitment to green practices such as recycle, reuse and reduce materials. In actuality, corporations react actively towards social values can achieve a social image and social legitimacy for their long-term survival and competitiveness [20]. In support, Uchida and Ferraro [21] found that firms combine environmental and organizational practices can create a competitive advantage to enhance profitability, access to new market, strengthen customer relationships and gain competitive edge. As such, some firms may also mimic environmental practices that successful leading firms have adopted.

In today’s global environmental demands, the focus of firm performance has changed. Previously, it focused primarily on the creation of wealth through superior economic performance in terms of success in assets, liabilities and overall market strength, but now focuses on environmental and social performance while achieving the high economic performance [22] in order to reach optimal levels of sustainability performance. Sustainability is a business strategy that is closely related to corporate social responsibility. Specifically, the organization, environment and society are the triads that are mutually dependent for a shared value or a “win-win-win” solution. In order to achieve a long-lasting competitive advantage, organizational sustainability requires the intersection of economic, environmental and society superiority [23] [24]. This means businesses should focus on long-term profitability that could simultaneously reduce the environmental and societal risks [25]. Therefore, GSCM practice is in a prime position to leverage sustainability performance in terms of economic, environmental and social.

One of the major tenets of SCM is to coordinate the raw materials and components flow efficiently from various suppliers to manufacturing companies for the purposes of converting raw materials into finished products and fulfilling the value expectation of customers. Suppliers’ capabilities are directly linked to the firm’s ability to produce a product with higher quality and lower costs while meeting the delivery promise. In order to achieve organizational sustainability, firms need to pay attention to supply-side practices. Roa [2] argued that GSCM must involve collaboration with suppliers in designing green product, providing awareness seminars, and helping suppliers to build their own environmental program. Sarkis [26] provided further evidence that an increasing numbers of companies are adopting collaboration of environmental practices into their strategic plans and processes.

Collaboration effort between focal company and supplier is the main ingredient of GSCM to facilitate supply-side environmentally and socially responsible activities. Collaboration in terms of environmental is an approach that helps firms to develop and support the environmental prowess of their supply partners [27]. According to Paulraj [23], environmental collaboration includes cooperating with suppliers to achieve environmental objectives and improve waste reduction initiatives, providing suppliers with design specification that include environmental requirements for purchased items, encouraging suppliers to develop new source reduction strategies, working with suppliers for cleaner

production and helping suppliers to provide materials, equipment, parts and services that support organizational goals. Besides, top management plays a critical role in affecting the scope of an organizational sustainability practices. Accordingly, environmental collaboration is one of the initiatives responses to environmental problems, focuses on environmental protection, and promotes coordinated development of economic and environment perspectives [28].

2. Proposed Conceptual Model

The hypothesized model linking the relationship between GSCM practices, environmental collaboration and sustainability performance is depicted in Figure 1. The GSCM practices are conceptualized to include green procurement, green manufacturing, green distribution and green logistics. The sustainability performance is investigated from the perspectives of economic, environmental and social. The model is mainly grounded within the relational view to explain idiosyncratic inter-organizational linkages. The relational view theory was first articulated by Dyer and Singh [29] to suggest that established long-term collaborative relationship characterized by strong inter-organizational interactions could facilitate firms to pursue GSCM practices. In general, the relational view provides insight into how a firm develops value-creating linkages with other firms to achieve high profit returns. Undeniably, the collaborative supply chain relationships are invariably based on trust, loyalty, a positive sum game, fairness in negotiations, goal and intent revelation, and commitment [9].

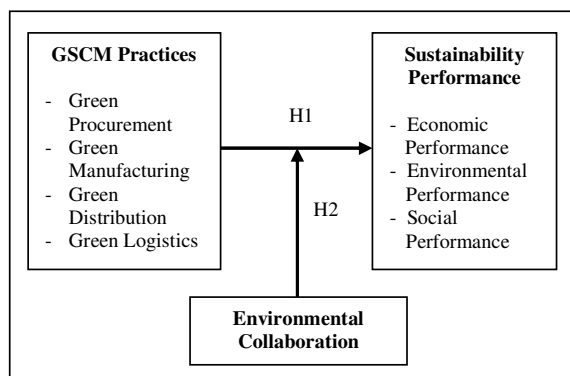


Figure 1: Proposed conceptual model

3. Hypotheses Development

GSCM practice is a multi-dimensional concept which can be measured from different perspectives. Different dimensions of GSCM practices have been highlighted in the past literature [11] [24] [30] [31] [32] [33] [34]. In 2005, Zhu et al. [30] proposed a four-dimensional GSCM practices, namely internal environmental management, external GSCM, eco-design and investment recovery. Holt and Ghobadian [31] suggested internal environmental management practices, logistics, supplier assessment and evaluation, green

procurement and logistics policy, supplier education and mentoring, and industrial networks as important GSCM practices. According to Ninlawan et al. [11] and Thoo et al. [24], green procurement, green manufacturing, green distribution and green logistics are important dimensions of GSCM practices needed by manufacturing sectors to achieve enhanced sustainability performance. Green et al. [32] suggested that GSCM practices should include internal environmental management, green information systems, green purchasing, cooperation with customers, eco-design and investment recovery. Lee et al. [33] noted that GSCM practices are composed of corporate and operational strategies to improve environmental sustainability such as internal environmental management, green purchasing, cooperation with customers and eco-design. Laosirihongthong et al. [34] investigated the impacts of pro-active (reverse logistics) and re-active (threat of legislation and regulation) practices of GSCM on economic, environmental and intangible performance in Thailand manufacturing companies. Taken together, these studies are representative of efforts to address the diversity of interesting dimensions of GSCM practices.

Based on the literature review of GSCM practices, this study has portrayed GSCM practices from four important perspectives: green procurement, green manufacturing, green distribution and green logistics [11] [24]. Green procurement is defined as a set of supply-side practices utilized by an organization to effectively select suppliers based on their environmental competence, technical and eco-design capability, environmental performance, ability to develop environmentally friendly goods and ability to support focal company's environmental objectives [23]. Furthermore, the 3Rs: reuse, recycle and reduce in the process of green procurement in terms of paper and parts container (plastic bag/box), place purchasing orders through email (paperless) [11] [31] [32] [33], use eco labeling of products, ensure suppliers' environmental compliance certification and conduct auditing for suppliers' internal environmental management [33] are also emphasized in this study.

Green manufacturing is a productions process which converts inputs into output by reducing hazardous substances, increasing energy efficiency in lighting and heating, practicing 3Rs, minimizing waste [11], actively designing and redesigning green processes [30] [31] [32] [33]. According to Zhu et al. [30], Green et al. [32] and Lee et al. [33], green manufacturing requires manufacturers to design products that facilitate the reuse, recycle and recovery of parts and material components; avoid or reduce the use of hazardous products within production process; minimize consumption of materials as well as energy.

Green distribution consists of green packaging with the aims to (1) downsize packaging, (2) use "green" packaging materials, (3) promote recycling and reuse programs, (4) cooperate with vendor to standardize packaging, (5) encourage and adopt returnable packaging methods (6) minimize material uses and time to unpack [11], (7) use recyclable pallet system and lastly, (8) save energy in warehouses [31].

As for green logistics/transportation, it is about delivering goods directly to user site, using alternative fuel vehicles and

grouping orders together, rather than in smaller batches [11], investing in vehicles that are designed to reduce environmental impacts, and planning vehicle routes [31]. As stated by Laosirihongthong et al. [34], green logistic is about reverse logistic that includes collecting used products and packaging from customers for recycling, returning packaging and products to suppliers for reuse, and requiring suppliers to collect their packaging materials.

Researchers [23] [30] [31] [34] have recommended sustainability performance, such as economic performance, environmental performance and social performance as important performance indicators. It is imperative to note that in the present paper, the proposed model may not comprise a complete set of measurement scale due to the constraint of encompassing the entire of GSCM practices and sustainability performance in a single study. The GSCM interacts with each other and can hold an organization together for sustainability performance, where the interaction has found to lead significantly to firm performance [32] [33]. Surprisingly, Laosirihongthong et al. [34] found that the pro-active (reverse logistics) practices do not have significant impact on GSCM performance. Thus, it is of interest for this study to explicitly examine the differences of green logistics findings in greater details. The above discussions develop the basis of the following hypothesis:

H1: GSCM practice is positively related to sustainability performance.

The benefits that can be derived from environmental collaboration have been recognized in the GSCM literature [23] [31]. Researchers have emphasized the direct relationship between GSCM practices and performance. Holt and Ghobadian [31] used external GSCM to see the impact of environmental collaboration on firm performance. Paulraj [23] sought a relationship between sustainable supply management and sustainability performance. In contrast to these studies, environmental collaboration is proposed as a moderator of the link between the GSCM practices and sustainability in view of the presence of the environmental collaboration could facilitate GSCM practices and firms which form collaborative relationships with suppliers would be easy to implement GSCM practices. In this context, environmental collaboration as a key relational capability could be advantageously positioned to facilitate the GSCM strategic formulation and execution. Therefore, the following hypothesis is proposed:

H2: Environmental collaboration moderates the relationship between GSCM practice and sustainability performance.

4. Sample, Data Collection and Measurements

The potential survey respondents are drawn from the “FMM directory of Malaysian Manufacturers 2013”. The directory contains information of manufacturing companies (large and small) from various sectors, locations, name of company, year of establishment, contact information, email address, annual sales, number of employees, etc. The population of this study consists of all medium and large manufacturing companies of Malaysia with a total of 37,694

[35]. The number of respondents acceptable for this study depends upon the statistical tool used – structural equation modeling (SEM). SEM is a large sample technique and the sample size required is more than 200 [36]. To meet the objectives of this study, a survey questionnaire is developed to measure the constructs of GSCM practices, environmental collaboration and sustainability performance. SEM is used to test H1 and H2 in a single, systematic, and comprehensive analysis by exploring the relationships among multiple independent and dependent constructs simultaneously [37].

5. Discussion and Conclusion

Based on the literature review, undoubtedly, GSCM and sustainability performance are two inextricably related SCM concepts. As noted earlier, majority of studies [24] [30] [32] have indeed reported a significant relationship between these two constructs. However, there are some issues such as involving collaboration with suppliers in designing green products and adopting environmental practices into processes have yet to be researched fully. In view of this matter, environmental collaboration has been proposed as a moderator of the link between GSCM practices and sustainability performance in this paper. The presence of the environmental collaboration is expected to facilitate GSCM practices, which would ease the implementation of GSCM practices.

The proposed conceptual model is mainly grounded within relational view theory which was articulated by Dyer and Singh in 1998 [29]. According to this theory, the establishment of long-term collaborative relationship characterized by strong inter-organizational interactions would facilitate firms to pursue GSCM practices. Specifically, this theory provides insight into how firms can develop value-creating linkages with others in order to achieve their desired outcomes. In conclusion, the proposed model, though helpful to some extent, still needs to be researched and fine-tuned before it can be usefully applied to the context of Malaysian manufacturing companies.

References

- [1] Wisner JD, Tan K-C, Leong GK. Supply chain management: a balanced approach. 3rd ed. Canada: South-Western Cengage Learning; 2012.
- [2] Rao P. Greening of suppliers/in-bound logistics – In the South East Asian Context. *Greening the Supply Chain* 2006; 189-204.
- [3] Srivastava SK. Green supply-chain management: a state-of-the-art literature review. *International Journal of Management Reviews* 2007; 9(1): 53-80.
- [4] Diabat A, Govindan K. An analysis of the drivers affecting the implementation of green supply chain management. *Resources, Conservation and Recycling* 2011; 55(6): 659-667.
- [5] Luthra S, Garg D, Haleem A. Green supply chain management. Implementation and performance – a literature review and some issues. *Journal of Advances in Management Research* 2014; 11(1): 20-46.
- [6] Beamon BM. Designing the green supply chain. *Logistics Information Management* 1999; 12(4): 332-342.
- [7] Mentzer JT. Supply chain management. United States of America: Sage Publications, Inc; 2001.
- [8] Chopra S, Meindl P. Supply chain management: strategy, planning, and operation. 4th ed. Upper Saddle River, New Jersey: Pearson Education, Inc; 2010.

- [9] Chandra K, Kumar S. Supply chain management in theory and practice: a passing fad or a fundamental change? *Industrial Management & Data System* 2000; 100(3): 100-113.
- [10] Li S, Subba Rao S, Ragu-Nathan TS, Ragu-Nathan B. Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management* 2005; 23: 618-641.
- [11] Ninlawan C, Seksan P, Tossapol K, Pilada W. The implementation of green supply chain management practices in electronics industry. *Proceedings of the International MultiConference of Engineers and Computer Scientists* 2010; March 17-19: Hong Kong.
- [12] Basher V. Vendor selection and quota allocation by using fuzzy topics and linear programming. *Master of Engineering in Production Engineering*. University of Delhi: India.
- [13] Tan KC. Supply chain management: practices, concerns, and performance issues. *Journal of Supply Chain Management* 2002; 38(1): 42-53.
- [14] Mohanty RP, Deshmukh SG. Supply chain management: theories and practices. Delhi: Biztantra Publication; 2005.
- [15] Quayle M. A study of supply chain management practice in UK industrial SMEs. *Supply Chain Management: An International Journal* 2003; 8(1): 79-86.
- [16] Meehan J, Muir L. SCM in Merseyside SMEs: benefits and barriers. *The TQM Journal* 2008; 20(3): 223-232.
- [17] Koh SCL, Demirbag M, Bayraktar E, Tatoglu E, Zaim S. The impact of supply chain management practices on performance of SMEs. *Industrial Management & Data Systems* 2007; 107(1): 103-124.
- [18] Damall N, Edwards Jr D. Predicting the cost of environmental management system adoption: the role of capabilities, resources and ownership structure. *Strategic Management Journal* 2006; 27(4): 301-320.
- [19] Flammer G. Corporate social responsibility and shareholder reaction: the environmental awareness of investors. *Academy of Management Journal* 2013; 56(3): 758-781.
- [20] Hoffman AJ. *Competitive environmental strategy. A guide to the changing business landscape*. United States of America: Island Press; 2000.
- [21] Uchida T, Ferraro PJ. Voluntary development of environmental management systems: motivations and regulatory implication. *Journal of Regulatory Economics* 2007; 32(1): 37-65.
- [22] Carter CR, Rogers DS. A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution and Logistics Management* 2008; 39(5): 360-387.
- [23] Paulraj A. Understanding the relationships between internal resources and capabilities, sustainable supply management and organizational sustainability. *Journal of Supply Chain Management* 2011; 47(1): 19-37.
- [24] Thoo AC, Abdul Hamid AB, Rasli A, Zhang D. The moderating effect of entrepreneurship on green supply chain management practices and sustainability performance. *Advanced Materials Research, Sustainable Development of Industry and Economy* 2014; 869-870.
- [25] Porter ME, Kramer MR. Strategy and society: the link between competitive advantage and corporate social responsibility. *Harvard Business Review* 2006; 84(12): 78-92.
- [26] Sarkis J. A strategic decision making framework for green supply chain management. *Journal of Cleaner Production* 2003; 11(4): 397-409.
- [27] Klassen RD, Vachon S. Collaboration and evaluation in the supply chain: the impact of plant-level environmental investment 2003; 12(3): 336-352.
- [28] Li Y. Research on the performance measurement of green supply chain management in China. *Journal of Sustainable Development* 2011; 4(3): 101-107.
- [29] Dyer JH, Singh H. The relational view: cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review* 1998; 23: 660-679.
- [30] Zhu Q, Sarkis J, Geng Y. Green supply chain management in China: pressures, practices and performance. *International Journal of Operations & Production Management* 2005; 25(5): 449-468.
- [31] Holt D, Ghobadian A. An empirical study of green supply chain management practices amongst UK manufacturers. *Journal of Manufacturing Technology Management* 2009; 20(7): 933-956.
- [32] Green Jr KW, Zelbst PJ, Meacham J, Bhaduria VS. Green supply chain management practices: impact on performance. *Supply Chain Management: An International Journal* 2012; 17(3): 290-305.
- [33] Lee SM, Kim ST, Choi D. Green supply chain management and organizational performance. *Industrial Management & Data Systems* 2012; 112(8): 1148-1180.
- [34] Laosirihongthong T, Adebajo D, Tan KC. Green supply chain management practices and performance. *Industrial Management & Data Systems* 2013; 113(8): 1088-1109.
- [35] SME Annual Report 2011/12. *Redefining the Future. SME Corporation Malaysia*. Retrieved from <http://www.smeCorp.gov.my/vn2/node/177>.
- [36] Kline RB. *Principles and practice of structural equation modeling*. 2nd ed. New York: Guilford Press; 2005.
- [37] Gerbing DW, Anderson JC. An updated paradigm for scale development incorporating unidimensionality and its assessment. *Journal of Marketing Research* 1988; 25: 186-192.