Full Length Research Paper

The study of knowledge transfer and green management performance in green supply chain management

Guo-Ciang Wu[1]*, Yu-Hui Cheng[2] and Shin-Ying Huang[3]

[1]Department of Marketing and Distribution Management, National Pingtung Institute of Commerce, 51 Min Sheng E. Road, Pingtung 900, Taiwan.
[2]Department of Logistics Management, National Kaohsiung Marine University, No.142, Haijhuan Rd., Nanzih District, Kaohsiung City 81143, Taiwan.
[3]Department of Business Administration, Southern Taiwan University, Taiwan.

The information communication and knowledge exchange based on environmental friendly require-ments among manufacturers is the critical success factor of green supply chain management (GSCM). The firms of IT industry in Taiwan with green supply chain implementation was used as the research objects to further explore constructs of knowledge transfer and the relationships between knowledge transfer and green management performance. The result showed that; (1) Information quality had significant positive impact on environmental management performance; (2) Information sharing and information quality did not have significant impact on positive economical performance; (3) Information sharing had positive significant impact on negative economical performance. The research findings revealed that firms should realize the effect of short-term costs and benefits on knowledge transfer in order to enhance green management performance.

Key words: Knowledge transfer, information sharing, information quality, green management performance, green supply chain management.

INTRODUCTION

Due to rapid worldwide industrialization that led to the destruction of environment in the recent years, industrial wastes severely damaged and polluted our environment and caused ozone depletion, greenhouse effect and Antarctic icebergs melt. Pollution not only affected the health of human beings, it also became a burden to global environments. Issues related to substantial deve-lopments set the public off to demand manufacturers on their industrial production responsibilities. With promotion of environmental awareness around the world along with the environmental laws and regulations formulated in Europe and U.S., such as Directives from European Parliament concerning environments of Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances Directive (RoHS), Energy Using

Product Directive (EuP) and so on, enterprises faced unprecedented challenges in international markets.

The firms in Taiwan are famous for their OEM/ODM producing efficiency. Becoming one of the most important OEM/ODM manufacturing centers for the international information and electronic brands, the firms in Taiwan have to accept the green product requirements from their clients (well-known brands). When the demands for ecological context gradually change the competitive advantage, enterprises have to respond the demands with strategies. In the green waves, the information and electronic manufacturers encountered important pro-blems on technical and management, the linkage on different streams in supply chain system in particular. If enterprises were not able to manage their green resources from upstream, they would be bound to pay more costs eventually.

Even though the information and electronic industry in Taiwan has had abundant supply chain integration experiences, many green regulations from environmental

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*Corresponding author. E-mail: gcwu@npic.edu.tw. Tel: 886-8-7238700 ext: 6133. Fax: 886-8-7210796.

directives still became the biggest challenge for green supply chain management. Environmental management in supply chain system is the management activity that crosses organizational boundaries and all these management activities are required with interactions and involvements from supply chain partners. Supply chain partners should build knowledge transfer mechanism together to face the complex procedures and environmental directives. The objective of this research is thus in exploring the relative types and measurement constructs of knowledge transfer among partners from different streams while manufacturers introducing green supply chain management in Taiwan, and further analyzing the relationships between knowledge transfer and green management performance improvement.

KNOWLEDGE TRANSFER

Under requirements of environment directives, organizations have to cope with the changes of environments and progressively proceed with internal and external knowledge transfer in order to gain innovative ability. The critical factors to accelerate knowledge transfer and innovation are trust among partners, knowledge transfer motivation, supports and learning orientation from managers while enterprises engage in knowledge transfer (Brachos et al., 2007). Knowledge exchange in supply chain management includes information of operational level and know-how of strategic level (Kwon and Suh, 2005). Knowledge transfer plays a really important role in supply chain management. The impacts of knowledge transfer on supply chain performances are depended on the types and methods of knowledge sharing. If instant and undistorted new market information is able to access in every supply chain node, the efficiency and effectiveness of supply chain could be improved by speeding up the flow of information in supply chain, and firms could cope with requirements of customers immediately via the information sharing from other supply chain partners.

Knowledge transfer could provide long-term competitive advantages in supply chains accordingly (Li and Lin, 2006). The exchange of implicit knowledge usually is difficult during learning process, and explicit knowledge is relatively easy to pass on. Different types of knowledge require different methods for the purpose of knowledge transfer (Chen, 2004). Focusing on types of supply chain knowledge transfer, Li and Lin (2006) divided them into two constructs, "Information sharing" and "Information quality". "Information sharing" stands for the critical and proprietary levels among communication complete, adequate, and reliable information exchange among supply chain partners. The timely provision of accurate knowledge transfer can strengthen the connections among supply chain partners, and avoid distorted or incomplete information among supply chain partners that may lead to inefficient operations (Larson, 1994; Lee et al., 1997).

KNOWLEDGE TRANSFER AND GEEN MANAGEMENT PERFORMANCE

In SCM, firms share information with their partners to decrease the incidence and affected levels of supply chain risks. However, the process of knowledge transfer is causally ambiguous and social complex (Vachon and Klassen, 2007). If supply chain partners have limited knowledge towards environmental management, it will impede the performances of firms (Zsidisin and Siferd, 2001; Prahinski and Kocabasoglu, 2006; Vachon and Klassen, 2007). In causally ambiguous, for instance, pollution control technology of production/process correction is somehow causally ambiguous with tacit knowledge exchange and is hard to be copied (Hart, 1995). In social complex, many advanced environmental management practices, such as environmental design and reverse logistics management, all require integration of different stakeholders from supply chain system (Vachon et al., 2001). Management of these integrations normally requires constructing the information sharing and knowledge transfer networks among manufacturers, suppliers and customers. The interactive information networks with mutual trust among the organizations reflect to the strength of knowledge transfer, and its potential benefits would reduce the risks of information asymmetry among supply chain partners. With high levels of information sharing, supply chain partners build long-term and joint-planning partnership to improve their performances (Claro et al., 2006).

Zhu et al. (2004) proposed environmental performance and economical performance are the constructs of organizational performance in GSCM. Environmental performance focused on the reduction of polluting substances emissions and environmental improvements, while economical performance focusing on the reduction of manufacturer waste cost and environmental disaster fine. In the study of green supply chain management, Vachon and Klassen (2008) found out that firms were able to improve their performances upon sharing environmental required relative information and joint planning environment-related solutions among upstream suppliers and downstream customers.

Rao (2002) dis-covered that the knowledge extension level had positive significant relationship with environmental performance of firms from the greening practices of suppliers. Zhu and Sarkis (2004) revealed that firms were able to improve their environmental and economical performances through information exchange and knowledge transfer in external green supply chain management practices.

RESEARCH DESIGN

Research framework and hypotheses

The purpose of this research is to explore the relationships between knowledge transfer and green management performance among
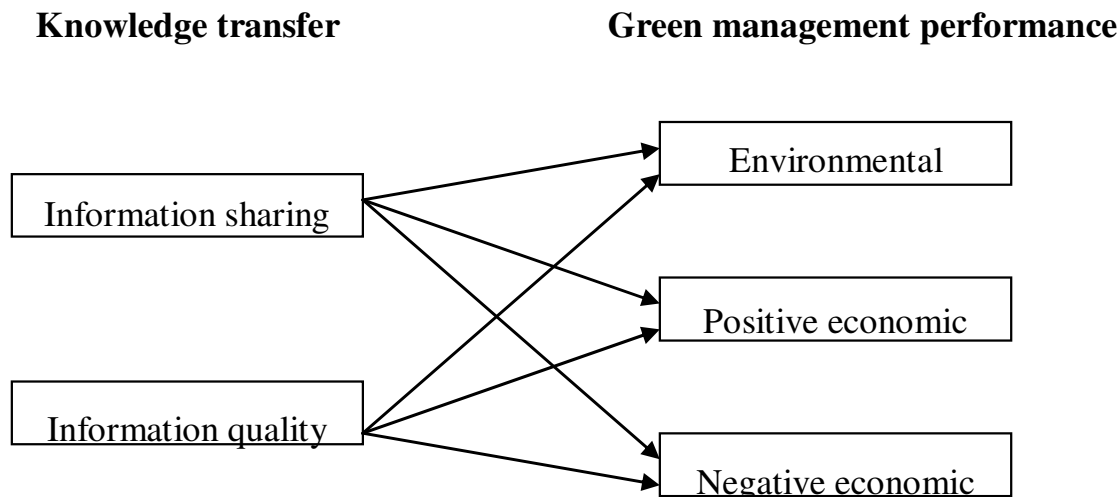
Knowledge transfer   Green management performance

Figure 1. Research framework for relationship between knowledge transfer and green management performance in GSCM.

supply chain partners during inducting greening supply chain management (GSCM). The research framework, shown in Figure 1, developed to examine the relationships between two constructs of knowledge transfer (information sharing and information quality) that firms may implement to improve their green management performance in GSCM. After summarizing literature reviews and research results from scholars, the hypotheses are proposed as following:

H1a: The higher the level of information sharing in knowledge transfer, the higher the level of environmental performance in GSCM.
H1b: The higher the level of information quality in knowledge transfer, the higher the level of environmental performance in GSCM.
H2a: The higher the level of information sharing in knowledge transfer, the higher the level of positive economic performance in GSCM.
H2b: The higher the level of information quality in knowledge transfer, the higher the level of positive economic performance in GSCM.
H3a: The higher the level of information sharing in knowledge transfer, the lower the level of negative economic performance in GSCM.
H3b: The higher the level of information quality in knowledge transfer, the lower the level of negative economic performance in GSCM.

Research constructs measurement items

Based on the research results of Li and Lin (2006) and Zhu et al. (2004), the research construct measurement items are listed as "information sharing", "information quality", "environmental performance", "positive economic performance" and "negative economic performance", adapting 7 point Likert scale for evaluation.

Sampling method and sample size

Random sampling was used in this research and the data used in this study consist of survey questionnaire responses form

managers of high-tech industry in Taiwan. The sample objects are from the ISO14001 firm list published by Ministry of Economic Affairs and firms involved in G plan also held by Ministry of Economic Affairs, as well as the enterprises with capitals over one thousand million NTD from "Association of Industries in Science Parks" and "Taiwan Electrical and Electronic Manufacturers Association" in Taiwan. The respondents are managers and supervisors in purchasing and quality assurance departments, who have real understanding of green supply chain management. 238 questionnaires were returned, and after eliminating 26 invalid samples, there were 202 valid samples.

ANALYSIS AND RESULTS

Reliability and validity analysis

This research is analyzed by reliability and validity, and the reliability analysis of each construct is shown as Table 1. We can see from Table 1 that Cronbach's α is greater than 0.7 in every construct, which ensures that each construct of this research questionnaire in compliance of the requirements of internal consistency.

In order to verify the validity of this questionnaire, this research analyzed with factor analysis for every construct. The analysis result is shown as Table 1. We can see from Table 2 that factor loading of all items are greater than 0.5, which meets the standard of minimum absolute value of 0.5 and it is able to explain over 50% of variation. It is clear that every construct of this research is in line with the validity requirements.

Multiple regression analysis

Multiple regression analysis was conducted to verify the influence of factors in knowledge transfer on each construct in green management performance. The analysis

Table 1. Reliability and factor analysis for knowledge transfer and green management performance

Factor	Survey items	Factor loading	Eigen-value	Cumulative explained variation (%)	Cronbach's α
Information sharing	We inform trading partners in advance of changing needs	0.738			
	Our trading partners share proprietary information with us	0.905	2.006	66.855	0.741
	Our trading partners share business knowledge of core business processes with us	9.802			
Information quality	Information exchange between our trading partners and us is timely	0.857			
	Information exchange between our trading partners and us is accurate	0.942			
	Information exchange between our trading partners and us is complete	0.927	4.118	82.357	0.945
	Information exchange between our trading partners and us is adequate	0.922			
	Information exchange between our trading partners and us is reilable	0.887			
Environmental performance	Reduction of air emission	0.884			
	Reduction of waste water	0.899			
	Reduction of solid wastes	0.883			
	Decrease of consumption for hazardous/harmful/toxic materials	0.852	4.236	70.601	0.914
	Decrease of frequency for environmental accidents	0.746			
	Improve a enterprise's environmental situation	0.764			
Positive economic performance	Decrease of cost for materials purchasing	0.824			
	Decrease of cost for energy consumption	0.898			
	Decrease of fee for waste treatment	0.907	3.824	76.474	0.919
	Decrease of fee for waste discharge	0.898			
	Decrease of fine for environmental accidents	0.842			
Negative economic performance	Increase of investment	0.925			
	Increase of operational cost	0.887			
	Increase of training cost	0.871	3.002	75.038	0.888
	Increase of cost for purchasing environmentally friendly material	0.776			

result is shown as Table 2. As seen, "information quality" has positive and significant influence on "environmental performance", and "information sharing" has positive and significant influence on "negative economic performance". Both "information sharing" and "information quality" have no significant influence on "positive economic performance". The results of this research supported hypothesis H1b and were contrary to hypothesis H3. As for the other research hypotheses were all not supported.

DISCUSSION AND CONCLUSION

The main purpose of green supply chain management is to reduce environmental pollution by creating green products. It is an energy and resource saving product starting from adapting green materials, designs, manufacturing, and packaging to reduce resource and environmental pollution.

The influence of information sharing on environmental performance is not significant because that meets the standards of green directives has already becoming the common consensus among firms in green supply chain management. However, it can help to improve environmental management performance in the process of supply chain integration if information delivery quality is timely and accurately enhanced.

Secondly, even though practicing green supply chain management is able to reduce costs in wastes and environmental safety in economical performance, but lots of funds must be thrown in during green knowledge transferring in educating staffs, communication and

Table 2. Multiple regression analysis of green management performance.

IV	DV : green management performance					
	Environmental performance		Positive economic performance		Negative economic performance	
	standardized coefficient β	p	standardized coefficient β	p	standardized coefficient β	p
Information sharing	0.007	0.939	-0.070	0.461	0.326	0.000***
Information quality	0.352	0.000***	0.139	0.142	-0.070	0.442
F	14.503		1.135		8.731	
p	0.000***		0.323		0.000***	
R²	0.127		0.011		0.081	
Adjust R²	0.118		0.001		0.071	

*p < 0.05; **P < 0.01; ***P < 0.001.

information network construction.

The firms in Taiwan are mainly small and medium-sized enterprises and most manufacturers have difficulties in affording high costs in knowledge transfer during greening supply chain practices. The information sharing from knowledge transfer is hence unable to provide with greening competitive advantages in short-term. That is why it is has no significant influence on positive economic performance, and has significant positive influence on negative economic performance.

In addition, the sample data of this research includes various sub-industries of high-tech industry in Taiwan. Each sub-industry has different green standards to comply with, and its development and involvement in green supply chain management is also different. Therefore, different sample objects from different industries may consequent in this research results.

Future research suggestions

The sample objects of this research was mainly focusing on Taiwan high-tech industry, and the suggestion for further research is to explore on the actual green supply chain management practices of other industries. In green supply chain management promotion, high-level mana-gers play important roles. With their recognition of green management, full supports and implementations, it will be able to help on the green management performances. Consequently, the future research can further explore on case studies.

ACKNOWLEDGEMENTS

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