

A Comparison of Regulatory Awareness and Green Supply Chain Management Practices Among Chinese and Japanese Manufacturers

Qinghua Zhu,^{1,2*} Ying Qu,² Yong Geng³ and Tsuyoshi Fujita⁴

¹*Antai College of Economics & Management, Shanghai Jiao Tong University, Shanghai, People's Republic of China*

²*School of Business Management, Dalian University of Technology, Dalian, Liaoning Province, People's Republic of China*

³*School of Environmental Science and Engineering, Shanghai Jiaotong University, Shanghai, People's Republic of China*

⁴*Environmental Technology Evaluation System Section, National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan*

ABSTRACT

Leading manufacturers in developed countries generally have high environmental awareness and implement proactive environmental management practices such as green supply chain management (GSCM). However, it is uncertain if smaller manufacturers in developed countries are more proactive than all manufacturers in developing countries. To understand this situation, we carried out surveys among small and medium-sized Japanese manufacturers, leading Chinese manufacturers and traditional Chinese manufacturers. Statistical results show that leading Chinese manufacturers have the highest awareness of both domestic and international environmental regulations/policies, and implement all GSCM practices at the highest level. Leading Chinese manufacturers and Japanese manufacturers are aware of international environmental regulations/policies, but such awareness only motivates them to implement eco-design practices. Traditional Chinese manufacturers have limited awareness of international environmental regulations/policies, but such awareness brings all types of GSCM practice. Such results can be helpful for different manufacturers in both developed and developing countries to develop suitable environmental strategies. Copyright © 2015 John Wiley & Sons, Ltd and ERP Environment

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*Correspondence to: Qinghua Zhu, Antai College of Economics and Management, Shanghai Jiao Tong University, Shanghai, People's Republic of China. E-mail: qhzh@sjtu.edu.cn

Introduction

ENERGY SAVINGS AND POLLUTION REDUCTION HAVE BECOME TWO MAIN CHALLENGES ALL OVER THE WORLD. DUE TO the requirements of the Kyoto Protocol, developed countries have developed regulations and programs to reduce greenhouse gas emissions, which mainly target energy saving. To reduce pollution, developed countries, followed by developing countries, have enacted regulations to control environmental impacts through the whole life cycle of products. Typical examples are two European Union directives, namely, the Restrictions of Hazardous Substances (RoHS) from the suppliers' side, and the Waste Electrical and Electronic Equipment (WEEE) for end-of-life products. Besides these specific regulations, more general regulations such as Chinese circular economy promotion laws have been enacted (Geng and Doberstein, 2008). At the same time, more general programs such as eco-industrial park initiatives have been implemented in both developed countries (Conticelli and Tondelli, 2013, Romero and Ruiz, 2013) and developing countries (Zhu *et al.*, 2010a). All these regulations and programs mainly target manufacturers, which are energy intensive and traditional polluters. As a result, manufacturers in both developed countries and developing countries have struggled to implement innovative environmental management practices to realize energy saving and pollution reduction.

To reduce energy consumption and environmental impacts of a product through the whole life cycle, manufacturers have to go beyond the boundary of their companies to implement green supply chain management (GSCM), that is, integrating environmental effort into their SCM (Zhu *et al.*, 2007). Leading companies in developed countries such as Japan are always proactive to environmental requirements, implementing innovative GSCM practices before and beyond regulatory requirements (Hosogai *et al.*, 2009). For example, leading Japanese manufacturers implement GSCM at a higher level than Chinese manufacturers, and thus bring more performance improvement, especially for economic performance (Zhu *et al.*, 2010b). Limited studies on comparisons of corporate environmental management (Kim *et al.*, 2012), especially for those between developed countries and developing countries (Zhu *et al.*, 2008), generally show that learning experiences of companies in developed countries can be helpful for manufacturers in developing countries to better implement GSCM practices. However, manufacturers in developing countries have different clusters in terms of their GSCM practices, while leading manufacturers may implement GSCM practices at a high level (Zhu *et al.*, 2012). Thus, it is unclear if all manufacturers in developed countries have higher regulatory awareness and implement GSCM practices at a higher level than all manufacturers in developing countries. In other words, can all manufacturers in developed countries be the benchmark for manufacturers in developing countries to develop environmental business strategy and implement GSCM practices? Should all manufacturers in developing countries learn from manufacturers in developed countries? To answer such questions, we chose three types of manufacturer, small and medium-sized Japanese manufacturers, leading (high-tech based) Chinese manufacturers and traditional Chinese manufacturers, and carried out surveys. We compared awareness of domestic and international regulations/policies as well as GSCM implementation among these three types of manufacturer. Our results can extend the benchmark theory to develop the learning mechanism for proactive corporate environmental strategies among different types of manufacturer in developed and developing countries.

Ecological modernization theory (EMT) suggests that manufacturers may develop environmental strategies and implement environmental management practices to respond to regulatory requirements (Mol, 1995). However, manufacturers may implement environmental management practices at different levels due to different environmental regulatory awareness (Sondergard *et al.*, 2004). A study using data from 225 companies in seven European regions identifies that different regulatory requirements in specific countries have different effects on environmental management strategies and practices among companies even in the same sector (Daddi *et al.*, 2014). Based on the EMT perspective, we further compare relationships between regulatory awareness and GSCM practices among three types of manufacturer. The research implications can benefit governments to further develop and implement appropriate regulations and policies. Moreover, we provide implications for all three types of manufacturer as well as other manufacturers, in both China and Japan, to better understand their situations and then develop effective environmental strategies to increase their international competitiveness.

Environmental Regulations and GSCM Practices

Background of Environmental Regulations in Japan and China

Both Japan and China have developed regulations and policies for energy saving and pollution reduction. Generally, Japan has earlier and stricter regulations while China has increasingly paid attention to environmental and energy related issues and thus developed a series of regulations and policies.

As a leading developed country for energy saving, Japan publicized and implemented the Energy Saving Law in October of 1979; this was modified twice in 1998 and 2003, respectively. As a large manufacturing developing country, China publicized the Energy Saving Law in 1997, and then has implemented it since 1 January 1998, which is almost 20 years later than the Japanese Energy Saving Law. On 28 October 2007, China modified the law, and then began to implement the new Energy Saving Law on 1 April 2008.

Besides the specific law for energy saving, Japan has developed general laws and programs to promote innovative environmental practices among manufacturers. One typical law is the Basic Law for Establishing a Recycling-Based Society, which has been effective from April of 2001. This law mainly encourages material circulation, and thus reduces both consumption of natural resources and environmental pollution. As early as 1997, Japan initiated an eco-town program (Goto *et al.*, 2005). The aim of this program was twofold: to extend the life of existing landfill sites, and to revitalize local industries. The program established 26 eco-towns across the whole of Japan with a total investment of about 1.65 billion US dollars for 61 innovative recycling projects, including an average government subsidy of 36%, and it has brought both economic and environmental benefits (Van Berkel *et al.*, 2009b).

Similar to Japan, in 2003 China initiated demonstration projects of eco-industrial parks, which aim to improve economic performance with less environmental harm (Zhang *et al.*, 2010). Since 2004, China has extended eco-industrial park initiatives to a circular economy policy, which promotes continuous economic development without bringing significant environmental and resource challenges (Yuan *et al.*, 2006). The circular economy program in China has evolved from the concept to demonstration projects (Yong, 2007). From the legislation point of view, the Circular Economy Promotion Law was approved by the Standing Committee of the 11th National People's Congress of China on 29 August 2008, and became effective from 1 January 2009. This law aims at promoting the development of the circular economy, improving resource utilization efficiency, protecting the natural environment and thus realizing sustainable development. To date, as the leading agency on promoting circular economy, the National Development and Reform Commission (NDRC) has initiated two rounds of national circular economy pilot projects at different levels, including 109 enterprises, 33 industrial parks, 19 cities and seven provinces (Xue *et al.*, 2010).

Regulatory Awareness and GSCM Practices among Different Manufacturers

All regulations and programs related to energy saving and pollution reduction, in both Japan and China, mainly target manufacturers. However, manufacturers tend to be aware of these regulations at different levels, and thus implement GSCM practices differently.

Countries develop different environmental regulations and policies, and such differences moderate association of regulatory awareness with GSCM practices (Wagner, 2009). Manufacturers in different countries usually implement innovative environmental management practices such as GSCM at the different levels (Gonzalez-Torre *et al.*, 2004). Generally, Japanese manufacturers are more likely to implement GSCM practices, which bring more economic benefits (Zhu, 2010). However, with less strictness and ineffective enforcement of regulations, developing countries such as China have suffered in that their manufacturers are not well aware of these regulations and do not actively implement environmental management practices (Lau and Wang, 2009).

Different clusters of manufacturers exist in terms of GSCM practices (Shang *et al.*, 2010). Larger manufacturers are more likely to implement environmental management practices (Campos, 2012) for different reasons. First, larger manufacturers tend to gain more economic and environmental benefits through environmental practices (van Hoof and Lyon, 2013). Second, larger companies usually have more resources, and they can take risk to invest environmental practices. For example, large German companies tend to adopt a risk-oriented GSCM strategy with a focus on supplier evaluation and selection (Harms *et al.*, 2013). In contrast, smaller manufacturers may take environmental initiatives, but significantly fewer benefits can be perceived (Brammer *et al.*, 2012). Besides, larger

manufacturers are normally more targeted by environmental regulations, and thus more actively implement environmental management practices (Zhu and Sarkis, 2004). However, smaller manufacturers are generally reactive to energy saving and pollution reduction regulations and programs, since they feel it difficult to achieve win-win environmental and financial benefits through environmental management practices (Revell, 2007). Besides, leading companies with stronger environmental commitments are more proactive to implement environmental management such as GSCM practices (Orsato, 2006; Roy and Therin, 2008).

As mentioned in the introduction, we aim to compare three types of manufacturer, namely, small and medium-sized Japanese manufacturers, leading Chinese manufacturers and traditional Chinese manufacturers. Based on discussions above, we put forward two hypotheses.

Hypothesis 1. The three types of manufacturer have different awareness of regulations/policies on energy-saving and pollution reduction.

Hypothesis 2. The three types of manufacturer implement GSCM practices at different levels.

Effect of Environmental Regulations/Policies on GSCM Practices

According to the EMT, manufacturers would implement environmental practices due to regulatory requirements (Sondergard *et al.*, 2004). Regulatory efforts can encourage manufacturers to initiate eco-design, and also motivate manufacturers to consider environmental impacts along their supply chains (Pilkington and Dyerson, 2002). Innovative environmental practices first result from regulations and voluntary agreements, but such practices should be aligned with existing business procedures and directions (de Caluwe, 2004). Different environmental strategies of companies affect the level of compliance and efforts on GSCM practices (Yang and Sheu, 2009). Manufacturers who experience higher stakeholder pressure or recognize better the importance of stakeholder influences are more likely to participate in voluntary environmental programs (Darnall *et al.*, 2010). Generally, small and medium-sized companies pay less attention to regulations, and thus are more reluctant to implement proactive environmental management practices (Roy and Therin, 2008).

Based on discussions above, we put forward the third hypothesis.

Hypothesis 3. Regulations have different effects on GSCM implementation among the three types of manufacturer.

Methodology

Item Development and Data Collection

Item Development

Measurement items about regulatory awareness are developed according to existing regulations and policies on energy saving and pollution reduction, including three domestic ones and three international ones (see details in Table 1). The first domestic item concerns the Energy Saving Law, which was enacted in 1998 in Japan and in 2008 in China. The second one is about the Circular Economy Promotion Law, which has been implemented since 2000 in Japan and 2009 in China. The third one is about eco-industrial park demonstration projects, which were initiated in 1997 in Japan and in 2003 in China. Three international items are the Kyoto Protocol, extended producer responsibility laws such as those in the EU, and restriction of hazardous substance laws such as those in the EU. Questions on awareness were answered by using a five-point scale: 1, have never heard about it; 2, have heard about it but do not know details; 3, know it but do not know relationship with the company; 4, have considered practices due to it; 5, have initiated practices due to it.

	Component	
	1	2
Energy Savings Law	<u>0.805</u>	0.276
Circular Economy Promotion Law	<u>0.886</u>	0.256
Eco-industrial park demonstration projects	<u>0.836</u>	0.228
Kyoto Protocol	0.212	<u>0.830</u>
Extended producer responsibility laws such as those in EU	0.384	<u>0.796</u>
Restriction of hazardous substance laws such as those in EU	0.214	<u>0.892</u>

Table 1. Exploratory factor analysis on awareness of environmental regulations/policies

Extraction method: principal component analysis.

Rotation method: varimax with Kaiser normalization.

Rotation converged in three iterations.

Twenty-four measurement items about GSCM practices are mainly based on a previous study of GSCM practices (Zhu *et al.*, 2005). Questions were answered by using a five-point scale: 1, not considering it currently; 2, planning to consider it; 3, considering it currently; 4, partly carrying out; 5, fully carrying out.

Data Collection

Due to the difficulty of undertaking a wide survey all over China and Japan, we first chose typical industrial cities and then identified suitable industrial zones in both China and Japan. Shenyang, located in northeastern China, is the capital of Liaoning Province and a traditional industrial city in China. Thus, we chose two industrial zones in Shenyang as our survey areas. Kawasaki Eco-Town is one of the first and the best-known eco-town projects in Japan (Hashimoto *et al.*, 2010), and many small and medium-sized manufacturers are located there. Thus Kawasaki was chosen as a case study area in Japan. Another reason that we chose these two cities is that Shenyang and Kawasaki have been sister cities since 1981 due to their similar industrial structure. There have been a lot of exchange activities between the two cities, including a broad industrial collaboration.

The first Chinese industrial zone is the Shenyang Economic and Technological Development Zone (Shenyang Development Zone). The Shenyang Development Zone was established in June of 1988, and became an industrial zone at the national level in April of 1993. Five industrial clusters in this zone are equipment manufacturing, automobile/motorcycling, pharmaceuticals and chemicals, textiles and dyeing, and electronic/electrical. The key goal of this zone is to become a national manufacturing base. Many of these industries were established during the planning economy period (1950s–80s), and are state owned and relatively large. They were relocated to the present site in the late 1990s and early 2000s. We chose manufacturers in this zone as representative of traditional Chinese manufacturers.

The other Chinese industrial zone is the Shenyang Hi-tech Industrial Development Zone (Shenyang Hi-tech Zone). This zone was established in May of 1988, and was approved as a National High-Tech Zone in March of 1991. The key industries are electronics/information technology, advanced manufacturing, new materials and bio-medicine. Most of these companies were established in the late 1990s and early 2000s, and are high-tech based. We chose manufacturers in this zone as representative of leading ones in China.

Kawasaki is a coastal city located between Tokyo and Yokohama. It has become the center of the Keihin Industrial Area, the largest industrial area in Japan. In 1997, the waterfront industrial area of Kawasaki was chosen by the Japanese government to be one of the first four national eco-town projects. Currently, many small and medium-sized manufacturers are located there, and major industrial sectors include steel, chemical cement, nonferrous metal processing and paper making sectors. We chose small and medium-sized manufacturers from Kawasaki as representatives in Japan.

Before undertaking questionnaire surveys among the three industrial zones, we interviewed manufacturers in these three zones, including 24 from the Shenyang Development Zone, 7 from the Shenyang Hi-tech Zone and 5 from the Kawasaki Eco-Town. Such interviews guarantee that our questionnaire can be well understood by respondents. With the help of Shenyang and Kawasaki governments providing contact information and support letters, we received 567 usable questionnaires, including 330 usable questionnaires from the Shenyang Development Zone, 45 from the Shenyang Hi-tech Zone and 192 from the Kawasaki Eco-Town.

Factor Analysis

An exploratory factor analysis (EFA) is employed to identify the theoretical dimensions (factors) of awareness of environmental regulations/policies as well as GSCM practices. The maximum likelihood method with a varimax rotation is used to extract the theoretical factors. Both the scree test and the initial eigenvalue test (eigenvalues > 1) suggest two meaningful factors to characterize awareness of environmental regulations/policies, and four factors for GSCM practices.

Two factors of awareness of environmental regulations/policies explain 78.05% of the inherent variations. We label these two factors as awareness of domestic regulations/policies and awareness of international regulations/policies. Results in Table 1 show that all measurement items have high loadings on one factor (over 0.796) and low loadings on the other factor (less than 0.384), which indicates good results for factor grouping (Ramayah and Omar, 2010). The reliability coefficient alpha values are very high, with 0.856 for awareness of domestic regulations/policies and 0.857 for awareness of international regulations/policies.

Four factors for GSCM practices explain 79.13% of the variations. Loadings in Table 2 show that the factor grouping is reasonable, since all measurement items have over 0.648 loadings for one factor while less than 0.400 for the other three factors. According to characteristics of measurement items, we label the four factors as eco-design, customer cooperation with environmental concerns, green purchasing and investment recovery. The reliability coefficient alpha values for the four factors of GSCM practices are also high, namely, 0.957 for eco-design, 0.943 for green purchasing, 0.944 for customer cooperation with environmental concerns and 0.908 for investment recovery.

Results and Discussion

General Comparisons

We collected data from manufacturers among three industrial zones in two countries. The cultural differences including language differences and weighting differences (interpretation of scales) may bring biases for comparisons (Fischer, 2004). Ipsatization can be used to control the biases when respondents from one group systematically answer questions either more positively or more negatively than those from another group (Zhu *et al.*, 2008). Thus, we ipsatized (standardized) our data from the three groups, using grand means (Fischer, 2004; Raudenbush and Bryk, 2002), to avoid these possible biases. The ipsative adjustments include three steps: (1) we calculate means and standard deviations across items and individuals of awareness of regulations/policies and GSCM practices from three samples, and gain the grand means and grand standard deviations for each sample; (2) the grand means are subtracted from each item's raw scores, thus gaining the deviation scores; (3) the deviation scores are further adjusted by dividing them by the grand standard deviations. The results of ipsative data are shown in Table 3.

To understand if the three types of manufacturer have different awareness of regulations/policies and GSCM practices, we carry out analysis of variance (ANOVA) tests. The results of ANOVA tests in Table 3 show that both awareness factors and the four GSCM practices are significantly different among the three types of manufacturer at the significance level of 0.05.

Further, we use two-tailed independent-samples *t*-tests to do comparisons between each two of the three types. Generally, manufacturers in Shenyang Hi-tech Zone representing leading Chinese manufacturers have the highest regulatory awareness and implement GSCM practices at the highest level. Small and medium-sized manufacturers

Environmental Policies and Green Supply Chain Management

	Component			
	1	2	3	4
Design of products for reduced consumption of material/energy	0.263	0.270	<u>0.832</u>	0.173
Design of products for reuse, recycle, recovery of material, component parts	0.303	0.245	<u>0.834</u>	0.193
Design of products to avoid or reduce use of hazardous of products	0.328	0.244	<u>0.833</u>	0.200
Design of processes for minimization of waste	0.322	0.256	<u>0.810</u>	0.230
Providing design specification to suppliers that include ESER requirements for purchased items	<u>0.713</u>	0.376	0.234	0.203
Cooperation with suppliers for ESER objectives	<u>0.759</u>	0.303	0.270	0.216
Environmental audit for suppliers' inner management	<u>0.746</u>	0.314	0.267	0.206
Suppliers' ISO14001 certification	<u>0.756</u>	0.291	0.283	0.158
Second-tier supplier ESER practice evaluation	<u>0.816</u>	0.243	0.100	0.263
Adopting just-in-time logistics system	<u>0.772</u>	0.265	0.180	0.167
Suppliers are selected using ESER criteria	<u>0.711</u>	0.333	0.316	0.195
Require suppliers to use environmental packaging (degradable and non-hazardous)	<u>0.648</u>	0.336	0.341	0.211
Cooperation with customer for eco-design	0.400	<u>0.759</u>	0.159	0.264
Cooperation with customers for cleaner production	0.354	<u>0.759</u>	0.187	0.286
Cooperation with customers for green packaging	0.370	<u>0.727</u>	0.293	0.269
Cooperation with customers for using less energy during product transportation	0.371	<u>0.763</u>	0.309	0.202
Adopting third-party-logistics	0.279	<u>0.720</u>	0.337	0.166
Cooperation with customers for product takeback	0.357	<u>0.742</u>	0.252	0.227
Cooperation with customers for reverse logistics relationships	0.495	<u>0.657</u>	0.161	0.252
Investment recovery (sale) of excess inventories/materials	0.099	0.381	0.375	<u>0.694</u>
Sale of scrap and used materials	0.162	0.284	0.277	<u>0.726</u>
Sale of excess capital equipment	0.232	0.292	0.220	<u>0.776</u>
Collecting and recycling end-of-life products and materials	0.263	0.147	0.041	<u>0.860</u>
Establishing a recycling system for used and defective products	0.264	0.100	0.102	<u>0.826</u>

Table 2. Exploratory factor analysis on GSCM practices
 Extraction method: principal component analysis.
 Rotation method: varimax with Kaiser normalization.
 Rotation converged in six iterations.

	1. Shenyang Development Zone	2. Shenyang Hi-tech Zone	3. Kawasaki	ANOVA	2&1	3&1	2&3
Awareness of domestic regulations/policies	0.24	0.92	-0.21	19.07 ^{***}	3.64 ^{***}	-4.12 ^{***}	5.93 ^{***}
Awareness of international regulations/policies	-0.25	0.45	0.19	12.14 ^{***}	3.72 ^{***}	4.05 ^{***}	1.22
Eco-design	0.03	1.14	0.57	17.61 ^{***}	5.35 ^{***}	3.93 ^{***}	2.32
Customer cooperation with environmental concerns	-0.20	0.29	0.03	4.07 [*]	2.58 ^{**}	1.73 ⁺	1.25
Green purchasing	-0.15	0.42	0.02	4.89 ^{**}	3.05 ^{**}	1.39	2.03 [*]
Investment recovery	0.12	0.72	0.17	4.33 [*]	2.99 ^{**}	0.39	2.33 [*]

Table 3. Ipsative comparisons of regulatory awareness and GSCM practices
^{***} $p < 0.001$; ^{**} $p < 0.01$; ^{*} $p < 0.05$; ⁺ $p < 0.1$.

from Kawasaki in Japan have similar and somewhat lower levels of awareness and GSCM practice implementation compared with leading Chinese representatives. Manufactures in Shenyang Development Zone, representing traditional Chinese manufacturers, lag in both regulatory awareness and GSCM practice implementation.

For awareness of domestic regulations/policies, leading Chinese manufacturers have a significantly higher level than both small and medium-sized Japanese manufacturers and traditional Chinese manufacturers. Such a situation may result from the fact that Chinese regulations and policies mainly target leading manufacturers in the current initial stage (Lau and Wang, 2009). Hypothesis 1 is generally supported.

For awareness of international regulations/policies, leading Chinese manufacturers have a high level similar to that of small and medium-sized Japanese manufacturers while the level of traditional Chinese manufacturers is significantly lower. Such a result indicates that leading manufacturers in developing countries such as China are generally more sensitive to international environmental regulations/policies than other Chinese manufacturers, while even small and medium-sized Japanese manufacturers are concerned about these international environmental regulations/policies. Hypothesis 1 is supported.

For two GSCM practices, green purchasing and investment recovery, leading Chinese manufacturers implement at higher levels than both small and medium-sized Japanese manufacturers and traditional Chinese manufacturers. To promote energy saving and emission reduction, China has enacted regulations that have introduced green purchasing and investment recovery practices among Chinese manufacturers (Zhu *et al.*, 2010b). Leading manufacturers such as those in the Shenyang Hi-tech Zone have implemented investment recovery at a higher level. Hypothesis 2 is generally supported for these two GSCM practices.

For eco-design and customer cooperation with environmental concerns, leading Chinese manufacturers have an implementation level similar to that of small and medium-sized Japanese manufacturers, while these two types of manufacturer are significantly more proactive to implement these two practices than traditional Chinese manufacturers. Hypothesis 2 is also generally supported for these two GSCM practices.

A previous study indicates that leading Japanese manufacturers have higher environmental regulatory awareness and generally implement GSCM practices at a higher level than Chinese manufacturers (Zhu, 2010). Our results indicate that leading Chinese manufacturers have higher environmental awareness and are more proactive to implement GSCM practices than small and medium-sized Japanese manufacturers. Further, small and medium-sized Japanese manufacturers have higher awareness and thus implement GSCM practices at a higher level than traditional Chinese manufacturers.

Comparisons on Driving Effects of Regulatory Awareness on GSCM Practices

To further understand if a difference exists in the driving effects of regulatory awareness on GSCM practices among the three groups of manufacturers, we carry out a regression analysis between each GSCM practice (dependent factor) and two awareness factors (independent factors) for each group. Results are shown in Table 4. Hypothesis 3 is generally supported.

	Eco-design			Customer cooperation with environmental concerns			Green purchasing			Investment recovery		
	1	2	3	1	2	3	1	2	3	1	2	3
Awareness of domestic regulations/policies	0.17*	0.26*	0.38***	0.25***	0.56***	-0.01	0.16*	0.61***	0.30*	0.13	0.56***	-0.02
Awareness of international regulations/policies	0.35***	0.56***	0.29***	0.29***	-0.05	0.12	0.36***	-0.03	-0.01	0.31***	-0.03	0.17
Adjusted R ²	0.22	0.48	0.36	0.23	0.25	-0.01	0.22	0.32	0.07	0.15	0.25	0.01

Table 4. Comparisons on effects of regulatory awareness on GSCM practices

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

Table 4 shows that both awareness factors result in eco-design practices among all three types of manufacturer with six significant betas at $p < 0.05$. A further check indicates that Chinese manufacturers, both leading and traditional, are more influenced by awareness of international environmental regulations/policies with two betas at $p < 0.001$ while two betas for awareness of domestic environmental regulations/policies are at $p < 0.05$. Compared with Chinese manufacturers, Japanese manufacturers are affected by both domestic and international environmental regulations/policies at $p < 0.001$ while awareness of domestic regulations/policies has a higher beta, 0.38, than does awareness of international regulations/policies, with a beta of 0.29.

For customer cooperation, traditional Chinese manufacturers are influenced by both domestic and international regulations/policies, with two betas of 0.25 and 0.29 at $p < 0.001$, while leading Chinese manufacturers are only influenced by domestic regulations/policies, with a beta of 0.56 at $p < 0.001$. Such results are a little surprising but can be explained. Traditional Chinese manufacturers are not well aware of either domestic or international regulations/policies, but a little more awareness can be helpful for these manufacturers to implement practices of customer cooperation with environmental concerns. For leading Chinese manufacturers, such as these electronic firms, they have exported products, and thus have successfully implemented customer cooperation to meet international regulations such as WEEE (Zhu and Sarkis, 2006). However, these leading Chinese manufacturers have experienced increasing pressure from domestic environmental regulations/policies to cooperate with domestic customers. With the higher public awareness in Japan (Nakamaru, 2010), Japanese manufacturers, even small and medium-sized ones, are proactive to establish environmental images to gain competitiveness through logo programs (O'Connor, 2011), going beyond regulatory requirements. Thus, neither domestic nor international regulations/policies have an effect on customer cooperation among Japanese manufacturers.

For green purchasing, results in Table 4 show different effects of two awareness factors. Traditional Chinese manufacturers implement green purchasing due to awareness of both domestic and international regulations/policies, while international regulations/policies have a greater effect, with a beta of 0.36 at $p < 0.001$. Leading Chinese manufacturers and small and medium-sized Japanese manufacturers show similar results for the relationship between green purchasing and regulatory awareness, that is, only domestic regulations/policies have an effect. However, such similar results may arise for different reasons. In China, environmental regulations/policies mainly target leading manufacturers (Lau and Wang, 2009), and thus leading manufacturers are highly influenced by domestic regulations/policies. In Japan, regulations are generally stricter than in most other countries (Nie *et al.*, 2007), and as a result even small and medium-sized manufacturers are sensitive to domestic regulations/policies, rather than international regulations/policies.

For investment recovery, domestic regulations/policies only affect leading Chinese manufacturers, with a beta of 0.56 at $p < 0.001$, while international regulations/policies only affect traditional Chinese manufacturers, with a beta of 0.31 at $p < 0.001$. Such a situation may result from the current stage of environmental regulations/policies in China and motivation of environmental management practices among Chinese manufacturers. Traditional Chinese manufacturers that export their products have to follow international regulations, and Chinese regulations/policies mainly target these leading manufacturers. Japanese manufacturers implement investment recovery not only to meet regulatory requirements, but mainly to achieve financial gains by saving resources and reducing waste discharge (Van Berkel *et al.*, 2009a) or consider it a social responsibility (Nakamaru, 2010).

Findings

Statistical results from the ipsative comparisons show that leading Chinese manufacturers have the highest environmental awareness of both domestic and international regulations/policies, and implement all GSCM practices at the highest level. Moreover, it is surprising that all Chinese manufacturers, both leading and traditional ones, have higher awareness of domestic regulations/policies than Japanese manufacturers. Such a situation may result from two simultaneous policies of strong environmental requirements (stick) and supports (carrot) by the Chinese government. As introduced above, China has continuously developed and updated a series of environmental regulations such as the Circular Economy Promotion Law enacted on 1 January 2009. Thus, Chinese manufacturers, especially the leading ones, have experienced pressures and implemented all GSCM practices at a high level. At the same time, the Chinese government has also developed policies on energy saving and emission reduction such as providing subsidies to encourage manufacturers to implement proactive environmental practices beyond regulatory requirements (Zhu *et al.*, 2011a). Such policies may be the reason that all Chinese manufacturers are aware of

domestic environmental regulations and policies, and such awareness results in most of the GSCM practices. In contrast, Japanese governmental policies on environmental issues were developed earlier, and most of these policies are generally mandatory and stable. As a result, small and medium-sized Japanese manufacturers are less aware of domestic regulations.

Statistical results show that both leading Chinese manufacturers and small and medium-sized Japanese manufacturers are aware of international regulations/awareness, but such awareness shows no effect on GSCM practices except eco-design. In contrast, traditional Chinese manufacturers are the least aware of international environmental regulations/policies, while such limited awareness can apply to all GSCM practices. Several potential reasons may exist for such situations. First, eco-design may be enough or at least helpful to overcome challenges from international regulations. Both leading Chinese manufacturers and Japanese manufacturers implement eco-design practices, and such product redesign with environmental concerns makes it unnecessary to implement other GSCM practices such as cooperation with suppliers and customers. Second, the reason may be the different stages of their environmental management practices for the three types of manufacturer (Zhu *et al.*, 2012). Leading Chinese manufacturers and Japanese manufacturers are familiar with these international regulations, and they have both integrated their environmental efforts into their SCM practices. As a result, these two types of manufacturer continue to implement all GSCM practices, while international regulations only affect their further efforts on eco-design practices. In contrast, traditional Chinese manufacturers just realize international environmental regulations, and they understand that they should implement all GSCM practices to avoid potential challenges.

Managerial Implications for Manufacturers

Based on results and discussion, different types of manufacturer can develop specific GSCM strategies considering the effect of domestic and international regulations. Leading Chinese manufacturers implement GSCM practices due to high awareness of both domestic and international regulations/policies. However, such leading manufacturers can develop more proactive environmental strategies to further improve their GSCM implementation levels. With such efforts, these leading manufacturers can receive more support from Chinese government. Moreover, they can improve their environmental image, which is important for their international competitiveness.

Traditional Chinese manufacturers are not very aware of international environmental regulations/policies, and their implementation levels for the four GSCM practices are low. This type of manufacturer is normally reactive to environmental policies. However, with stricter environmental regulations, they have to develop more active environmental strategies to avoid potential environmental challenges. Moreover, due to globalization, they also have to compete with international manufacturers.

Small and medium-sized Japanese manufacturers generally lag in awareness of environmental regulations and implementation of GSCM practices compared with leading Chinese manufacturers. To avoid potential violation of environmental regulations, they need to understand that they should learn from not only leading domestic manufacturers but also leading manufacturers in developing countries.

For other manufacturers, it is helpful to understand the situations of environmental regulatory awareness and GSCM practices among the three types of manufacturer in China and Japan. Manufacturers in developed countries such as Japan do not all have higher environmental regulatory awareness or implement proactive environmental management practices such as GSCM more actively. Thus, they need to reconsider their environmental strategies related to GSCM such as supplier selection and development.

Conclusions

Due to the increasing environmental pressures and resource scarcity, Chinese governments have developed regulations and policies. As a result, leading Chinese manufacturers have implemented GSCM practices at a higher level than small and medium-sized Japanese manufacturers. However, most traditional Chinese manufacturers

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still lag in both regulatory awareness and GSCM practices, even compared with small and medium-sized manufacturers in Japan. Japanese governments have developed stricter environmental regulations (Nie *et al.*, 2007), stimulating small and medium-sized manufacturers to implement eco-design and green purchasing practices. This may result from marketing pressure due to higher public environmental awareness in Japan, and thus Japanese manufacturers go beyond regulatory requirements to implement customer cooperation. Investment recovery has been highlighted in Japan (Van Berkel *et al.*, 2009b). However, similar to customer cooperation, it does not result from governmental regulations or policies, but is more likely due to economic benefits (Van Berkel *et al.*, 2009b).

Governments play a key role in stimulating manufacturers to implement environmental practices (Darnall *et al.*, 2010). However, the strictness and the enforcement level of environmental regulations are different among countries such as China and Japan (Nie *et al.*, 2007). Lack of regulations and policies is still the main challenge in China to promote innovative environmental management practices such as GSCM (Lau and Wang, 2009). Chinese governments should continue to develop stable environmental regulations and policies, and increase the enforcement levels. Besides, Chinese governments can target leading manufacturers in the initial stage, but at the same time they should consider how to diffuse experiences in leading manufacturers to other traditional manufacturers. Compared with developing countries, developed countries such as Japan generally enact stricter regulations. In addition, leading manufacturers in developed countries implement proactive environmental management practices beyond regulatory requirements (Hosogai *et al.*, 2009). Even so, Japanese governments should make more effort to motivate small and medium-sized manufacturers to implement innovative environmental practices.

Stakeholders' pressure beyond regulatory requirements can become even more important for GSCM practices such as packaging recycling programs in developed countries (Verghese and Lewis, 2007). International leading companies implement eco-design beyond regulatory requirements, and thus gain competitiveness through establishing industry standards (de Caluwe, 2004). Leading Chinese manufacturers should not only obey existing regulations/policies, but also develop more proactive environmental strategies and implement GSCM practices, and then retain the leading position in China or even gain competitiveness in the international market. Traditional Chinese manufacturers need to understand the trend of environmental regulations. To develop active environmental strategies and implement GSCM practices effectively, they have tried to learn from international counterparts (Zhu *et al.*, 2011b), but they can also learn from leading Chinese manufacturers. Small and medium-sized manufacturers in developed countries such as Japan need to be more sensitive to environmental regulations/policies, especially when they compete with international counterparts, even from developing countries such as China. Other manufacturers need to reconsider their GSCM strategies, especially when the three types of manufacturer examined above are in their supply chains.

There are several directions that are worth further study based on this research. First, we identify that, due to governmental efforts through regulations and demonstration programs, leading Chinese manufacturers have become aware of both domestic and international environmental regulations/policies and been motivated to implement GSCM practices. However, how to diffuse experiences in these leading manufacturers to other Chinese manufacturers needs further studies. Second, our statistical results show that even small and medium-sized Japanese manufacturers have gone beyond regulatory requirements to implement customer cooperation with environmental concerns and investment recovery. Such driving measures can be more sustainable. How can developing countries such as China learn from experiences in Japan to motivate most traditional manufacturers?

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