Evaluating Green Supply Chain Management Capability, Environmental Performance, and Competitiveness in Container Shipping Context

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Abstract: This study investigated crucial green supply chain management (GSCM) and firm performance dimensions based on global container shipping service. On the basis of a factor analysis, six GSCM dimensions: green policy, green shipping practice, green marketing, green collaboration with supplier, green collaboration with partner, green collaboration with customer, and three firm performance dimensions: reduction of pollutant, decrease of cost, improved competitiveness were identified. According to their factor means in the GSCM dimensions, a cluster analysis subsequently assigned responding firms into four groups, namely, the external green oriented group, the internal green oriented group, the high internal and external green oriented group, and the low internal and external green oriented group. Differences in firm performance and GSCM dimensions among groups were examined.

Keywords: Green Supply Chain Management (GSCM); Container Shipping Industry; Environmental Management; Resource-Based View

1. INTRODUCTION

Maritime transport not only connects countries, markets, businesses and people but also has been one of the main causes and effects of globalization. Maritime transport has been a dominant mode since over 90% of the global trade volume is carried by sea (Strandenes and Marlow, 2000; IMO, 2008) then transferred to rail or truck to reach their final destination. Because maritime transport is the most efficient modes of transportation over long distances, it has happened to open up the world since the ancient times, and lead to the process of globalization. Even though container shipping is relatively climate friendly compared to air and land-based transport, it is a considerable source of pollutants. Marine oil spills can cause catastrophic damage to marine life, the components in crude oil are very difficult to be cleaned up, and last for years in the sediment and marine environment (Panetta, 2003). Although discharging of cargo residues from carriers can pollute ports, waterways and oceans, and foreign and domestic regulations prohibit such actions, vessels still intentionally discharge illegal wastes. Ships also create noise pollution that disturbs natural wildlife, and water from ballast tanks can spread harmful algae and other invasive species (Meinesz, 2003). Ballast water taken up at sea and released in port is a major cause of unwanted exotic marine life. As a result, the container shipping industry is becoming increasingly linked to environmental problems and challenged by the need to combat the adverse environmental effects of its operations. The International Maritime Organization (IMO), the United Nations body which administers the international regulatory regime for shipping, for example, passed the International Convention for the Prevention of Pollution from Ships (MARPOL) and covered pollution by oil, chemicals, harmful substances in packaged form, sewage and garbage (Gollasch et al., 2007), and required compliance with the relevant environmental protecting laws.

The term of supply chain management has risen to prominence since the early of 1990’s (Oliver and Webber, 1982). It is frequently used to describe executive responsibilities in corporations (La Londe, 1997). Container shipping liners are integrating their operations vertically to enable them assume effective control of their supply chains. With the increased environmental concerns over the past decade, there is growing recognition that issues of environmental pollution accompanying industrial development should be addressed simultaneously in the operational process of supply chain management, thus contributing to the initiative of green supply chain management (Sheu et al., 2005). Hence, container shipping companies not only just comply with regular conventions and regulations but also have to be positively participate in internal green cooperation between functional departments and external green collaboration with main suppliers (e.g. fuel company, container company, shipbuilding company), supply chain partners (e.g. terminal operators, trucking company, stevedoring company), and main customers (e.g. shippers, forwarders). To help academicians, researchers and practitioners in understanding integrated Green supply chain management (GSCM) from a container shipping perspective is needed. Successful completion of GSCM is useful for container shipping organizations to create value and sustain competitiveness. The idea of GSCM is to eliminate or minimize waste (energy, emissions, chemicals/hazardous, solid wastes) along supply chain (Hervani et al., 2005). The answer to this challenge is complying with tightening environmental conventions, regulations, and laws in shipping by engaging in GSCM-related knowledge and capability. Not only does reduction of pollutants and decrease of cost; it also gives the company involved in improved competitiveness. The capability concept has been strongly emphasized in the strategic management literature and it is asserted that corporate business strategies should be built upon the strengths of a firm's capabilities (Lu, 2007). The resource-based view (RBV) suggests that core capabilities may be identified from firms' capabilities and resources (Wernerfelt, 1984; Barney, 1991). Further, any differences in firms' capabilities will affect their competitive advantages and disadvantages. Many authors have reported an association between capabilities and firm performance (Hafeez et al., 2002; Ray et al., 2004), and indicated that capabilities are strategically valuable to firms (Prahalad and Hamel, 1990; Hafeez et al., 2002). However, little has been done to examine GSCM in the context of container shipping industry from the resource-based view (RBV). This study fills the gap in the GSCM literature by examining whether there are different groups of container shipping firms in terms of GSCM, and the relationship between GSCM capability and firm performance, applying the theoretical framework of the RBV.

This paper aims to investigate crucial green supply chain management capability dimensions, and to classify main container shipping firms in Taiwan into groups depending on their green supply chain management capability. On the basis of the green supply chain management and environmental management literature, dimensions such as green policy, green shipping, green marketing, green collaboration with supplier, green collaboration with partner, and green collaboration with customer are assessed in this research. In particular, differences in firm performance among groups and the relationships between green supply chain management dimensions and firm performance are examined in this study. In the following section, the extant literature is reviewed to build the theoretical base presented in Section 2. Section 3 describes the questionnaire design and responses. The collected data were examined using factor analysis and cluster analysis. The results of the statistical analysis are detailed in Section 4. Section 5 concludes the paper. It provides an overall review of the study findings, identifies the study's contributions to the literature, explains its implications and limitations, and proposes suggestions for future research.

2. LITERATURE REVIEW

2.1. Resource-Based View and Green Supply Chain Management Capabilities

Resource-based view has been developed in work by Wernerfelt (1984), Barney (1986), Teece (1988), and Teece et al. (1994), for analyzing firm behavior and competitive strategy (Mowery et al., 1998). The RBV contends that the idiosyncratic resources and capabilities of firms are the key sources of sustained competitive advantage (Lynch et al, 2000). This premise appears to be supported by logistics and SCM research (e.g. Bowersox et al., 1999 and Lynch et al, 2000). According to Barney (1991) resources can be classified into physical capital resources, organizational capital resources, and human capital resources. Capabilities can be defined as the skills a firm needs to take full advantage of its assets. Capabilities are "complex bundles of individual skills, assets and accumulated knowledge exercised through organizational processes that enable firms to co-ordinate activities and make use of their resources" (Olavarrieta and Ellinger, 1997). Without such capabilities, assets are of little value. RBV is based on four basic tenets, which constitute the VRIO model: value (V), rareness (R), imitability (I), organisation support (O) (Barney, 1997). Both valuable and rare characteristics contribute to short-term competitiveness, because eventually, they can be imitated by competitors (Harlaftis, 1996). Competitive advantage comes out from firm specific skills and from teamwork not from single practices performance and individuals (Barney and Wright, 1998). Green supply chain management (GSCM) has emerged as an important new archetype for enterprises to achieve profit and market share objectives by lowering their environmental risks and impacts while raising their ecological efficiency (Zhu et al, 2005). GSCM advocating efficiency and synergy between partners, facilitates environmental performance, minimal waste and cost savings (Rao and Holt, 2005), and is attracting the increasing interest of researchers and practitioners of operations and supply chain management (Srivastava, 2007). Given that more restricted maritime pollution prevention conventions and regulations are likely to be imposed, container shipping executives must be prepared to implement GSCM to assess and improve the environmental performance of their supply chain bases. The reason can be found in the fact that, while green practices are easily imitated by competitors, GSCM capabilities are not. Consequently, the firm should develop its internal cross-functional GSCM capabilities and external inter-firms GSCM capabilities (i.e. green collaboration with supplier, customer, and other supply chain partner).

2.2. Environmental Performance and Competitiveness

Environmental performance was defined and formulated differently in every study. It is defined as the environmental impact that the enterprise's activity has on the natural milieu (Klassen and Whybark, 1999; Shrivastava, 1995; Stanwick and Stanwick, 1998). Although the content of environmental performance varied, this study dealt with environmental performance as expressed by the use of operational performance indicators referring to the resource use, waste generation, emissions or water consumption. Using fewer natural resources and less energy, reducing the volume of residues and lowering pollution levels is definitely positive for the environment and, at the same time, proves benefits to the enterprise, as its costs decrease and firms with a good ecological reputation that keep improving their economic performance too (Claver et al., 2007). It has been argued that success in addressing environmental issues may provide new opportunities for competition, and new ways to add value to core business programs (Hansmann and Kroger, 2001). Recent literature (Geffen and Rothenberg, 2000; Florida and Davison, 2001; Handfield et al., 2002) offers insight on potential patterns of supply chain relations for improving environmental performance. Environmental or green issues are becoming a source of competitiveness (Hitchens et al., 2000; Rao and Holt, 2005). Competitive advantage is the dominance and control by an enterprise of a characteristic, a skill, a resource or knowledge that increases its efficiency and allows it to have a definite edge over competitors (Bueno and Morcillo, 1994). Shrivastava (1995) stated that environmental management can reduce the negative effects of their activities on the natural environment and enhance firms' competitive position. Success in addressing environmental management could increase firm image (Hick, 2000) and provide new opportunities for firms to enhance their capabilities (Hansmann and Claudia, 2001). Bacallan (2000) also demonstrated that organizations could enhance their competitiveness through improvements in their green performance to comply with mounting environmental regulations, to address the environmental concerns of their customers, and to mitigate the environmental impact of their production and service activities.

3. METHODOLOGY

3.1. Measures

The measurement items for evaluating green supply chain management, environmental performance, and firm competitiveness were mainly from prior research. A preliminary exploratory field research was conducted via in-depth, descriptive case studies of green supply chain projects to gather contextual knowledge for developing the measurement scales. We developed or refined all of the scales according to the input from experienced shipping practitioners comprising captains, vice president, and managers. In addition, we validated the resulting scales with field pilot tests to ascertain their content validity, as well as construct reliability and validity. Table 2 and table 3 present the final measurement items employed for evaluating green supply chain management, environmental performance, and firm competitiveness. questionnaire questions were based on previous studies (Videras and Alberini, 2000; Shang et al., 2010; Lai et al., 2011; Kirchoff and Koch, 2011; Ginsberg and Bloom, 2004; Kalafatis et al., 1999; Lampe and Gazdat, 1995; Vachon and Klassen, 2008; Bowen et al., 2001; Ellinger et al., 2000; Carter and Carter, 1998) and judged relevant by operations managers in container shipping companies. Interviews with practitioners resulted in minor modifications to the wording of some questions and examples provided in some measurement items, which were ultimately accepted as possessing content validity. It should be noted that all items were structured such that the respondents could accurately assess the relationship from the perspective of her/his company (e.g., ‘‘to what extent do you agree that your company engages in the following GSCM activities with main suppliers, supply chain partners, and main customers?’’). Five-point Likert-type scale anchors were used. Respondents were asked to indicate their firm's level of implementation of each item, where 1 represented “Strongly Disagree” and 5 represented “Strongly Agree”. Environmental performance and firm competitiveness has also been frequently measured by green supply chain researchers (Zhu et al., 2007; Rao and Holt, 2005). Five-point Likert-type scale anchors were used, where 1 represented “Strongly Disagree” and 5 represented “Strongly Agree”.

3.2. Sample

The Directory of the National Association of Shipping Agencies and Companies in Taiwan in 2010 was used as survey source for this study. The survey questionnaires were administered by mail with postage-paid return envelope sent to 260 president, vice/president, manager, assistant manager, director, and vice director on 15th July 2011 and contacted by telephone to identify their willingness to participate in the survey. The initial mailing elicited 86 usable responses. A follow-up mailing was sent six weeks after the initial mailing. An additional 77 usable responses were returned. Therefore, the total usable number of responses was 163. The overall response rate for this study was 62.7%. Although the total response rate reached 62.7%, it is important to deal with the potential problem of non-response bias. A comparison of early (those responding to the first mailing) and late (those responding to the second mailing) respondents recommended by Armstrong and Overton (1997) was carried out in this study to test for non-response bias by *t*-tests analysis. The *t*-tests were performed on the two groups’ perceptions of the agreement of the GSCM, environmental performance, and firm competitiveness. There were no significant differences between the two groups’ perceptions of the satisfaction of the various items at the 5% significance level. Results therefore suggested that non-response bias was not a problem since late respondents' responses appeared to reflect those of first wave respondents.

Table 1 Profile of respondents (n=163)

Characteristics of respondents		Frequency	%
Job title	Vice president or above	12	7.4
	Manager/assistant manager	75	45.8
	Director/vice director	66	40.3
	Others	10	6.5
Department	Operation	88	54.0
	Management	34	21.0
	Sales	31	19.0
Seniority	Less than 10 years	23	14.2
	11-15 years	30	18.5
	16-20 years	36	22.1
	More than 20 years	74	45.2
Ownership	Local firm	31	19.1
	Foreign-local firm	10	6.3
	Foreign-owned firm	122	74.6
Numbers of employee	Less than 100	12	7.6
	101~200	19	11.5
	More than 200	132	80.9

The profiles of respondents' companies and their characteristics are displayed in Table 1. Results reveal that questionnaire survey respondents were vice presidents or above (7.4%), managers/assistant managers (45.8%), director/vice director (40.3%), and others (6.5%). In general, managers and directors are actively involved in and anchor operations in their businesses. More than 90% of responses come from director/vice director or above thus endorsing the reliability of the survey findings. This study identified a key informant, such as president, vice/president, manager, assistant manager, director, and vice director who are knowledgeable about the company's green supply chain management, environmental performance, and firm competitiveness. Since this study's main aim was to elicit respondents' perceptions of green supply chain management (GSCM) and firm performance dimensions based on global container shipping service, the views of managers or above were considered particularly useful. To assess confidence in their answers, respondents were also asked to indicate how long they had worked in the container shipping industry. Table 1 also revealed that over 80% of respondents had worked in the container shipping service industry for more than 10 years. The finding implied that respondents had abundant practical experience to answer the questions. As regards the ownership pattern, more than 70% of respondents were foreign-owned firms, while 19.1% and 6.3% were local firms and foreign-local firms, respectively. Table 1 also presented that over half (67.3%) of responding firms had been in operation for more than 15 years. Around 7.6% of the responding firms had fewer than 100 employees, while 80.9% had more than 201 employees. Results presented in Table 1 presented that 50.0% of respondents were operation department; 21.0% of respondents were management department and 19.0% of respondents were sales department.

3.3. Research Methods

The research was accomplished by conducting a questionnaire survey. The research steps included questionnaire design and various analysis methods, as described below.

3.3.1. Step 1: Questionnaire Design and Content Validity Test

The first step was selecting GSCM capability attributes by reviewing the literature on green/environmental logistics and supply chain management research. This was followed by the design of the questionnaire, personal interviews with GSCM practitioners, and a content validity test. The questionnaire design followed the stages outlined by Churchill (1991). Information sought was first specified, and then the following issues were settled: questionnaire type and its method of administration, the content of individual questions, form of response to and wording of each question, sequence of questions, and physical characteristics of the questionnaire.

In the process of determining questionnaire items, it is crucial to ensure the validity of their content, since this is an important measure of a survey instrument's accuracy. Content validity refers to the extent to which a test measures what the researcher actually wishes to measure (Cooper and Emory, 1995). The assessment of content validity typically involves an organized review of the survey instrument's content to ensure it includes everything it should and does not include anything it should not. The content validity of the questionnaire in this study was tested through a literature review and interviews with practitioners that is to say, questionnaire questions were based on previous studies (Videras and Alberini, 2000; Shang et al., 2010; Lai et al., 2011; Kirchoff and Koch, 2011; Ginsberg and Bloom, 2004; Kalafatis et al., 1999; Lampe and Gazdat, 1995; Vachon and Klassen, 2008; Bowen et al., 2001; Ellinger et al., 2000; Carter and Carter, 1998; Zhu et al., 2007; Rao and Holt, 2005) and judged relevant by operations managers in container shipping companies. Interviews with practitioners resulted in minor modifications to the wording of some questions and examples provided in some measurement items, which were ultimately accepted as possessing content validity. Accordingly, in this study, to ensure the reliability of the questionnaire, its English version was first developed and subsequently translated into Chinese by a maritime shipping management professor. The Chinese version was then translated back into English by another maritime economics and logistics professor. This translated English version was then checked against the original English version for any discrepancies, and adjustments were made to reflect the original meaning of the questions in English.

3.2.2. Step 2: Exploratory Factor Analysis

Factor analyses was conducted in order to identify and summarize a large number of GSCM attributes into a smaller, manageable set of underlying factors, called dimensions. A reliability test was conducted to assess whether these GSCM, environmental performance, and firm competitiveness dimensions were adequate.

3.2.3. Step 3: Cluster Analysis

Cluster analysis is the common term for a variety of numerical methods used to create objective and stable classifications (Everitt et al., 2001). The primary objective is to find groups of similar entities in a sample of data (Aldenderfer and Blashfield, 1984). In short, cluster analysis groups together individuals whose patterns of scores on variables are similar. To develop the GSCM capabilities of container shipping liners, a two-stage procedure was employed to take advantage of the strengths of hierarchical and nonhierarchical clustering approaches (Hair et al., 1998; Ketchen and Shook, 1996). Hierarchical clustering is useful to determine the number of clusters in the data. However, it can’t produce the most optimal cluster solution in terms of between-clusters heterogeneity. To do this, an iterative partitioning method (k-means) needs to be used (Aldenderfer and Blashfield, 1984). One-way analysis of variance (ANOVA) and a Scheffe test were then performed between the clusters and performance outcomes in order to identify the difference between clusters. All analyses were carried out using the *SPSS 12.0 for Windows* package, and results are presented in the following section.

4. RESULTS OF EMPIRICAL ANALYSES

4.1. Perceptions of GSCM, Environmental Performance and Firm Competitiveness

According to their aggregated scores for implementation level of the 21 GSCM attributes, respondents' perceptions ranged from neutral to strongly agree (their mean scores were all over 3.90). The top five GSCM attributes in respondents' firms were: (G1) my company has a clear environmental policy statement, (G2) my company managers have a commitment to and support for GSCM, (G13) achieving environmental common goals collectively, (G7) use environmental-friendly materials and equipments (e.g. non-toxic paint, electric deck machine, ballast water handling system), and (G5) adopt environmental-friendly design of shipbuilding (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank) (see Table 2). In contrast, respondents' firms showed lowest implementation level with regard to (G9) spend more budget on green advertising (mean scores were all below 4.00). To their aggregated scores for implementation level of the 11 environmental performance and firm competitiveness attributes, respondents' perceptions ranged from neutral to strongly agree (their mean scores were all over 3.76). The top five firm performance attributes in respondents' firms were: (P9) improved company’s service quality assurance, (P1) reduction of air emission (e.g. CO_2, SOx, NOx…), (P3) reduction of noise pollution, (P4) reduction of wastes (e.g. oily waste, sludge and rubbish), and (P2) reduction of waste water (e.g. sewage) (see Table 3). In contrast, respondents' firms showed lowest implementation level with regard to (P5) decrease of cost for materials purchasing (mean scores were all below 3.76).

4.2. Exploratory Factor Analysis

Factor analysis was used to reduce the 32 attributes to smaller sets of underlying factors (dimensions). This helped to detect the presence of meaningful patterns among the original variables and to extract the main factors. Principal components analysis with VARIMAX rotation was employed to identify key dimensions (see Table 2 and table 3). The data were deemed appropriate for analysis, according to the Kaiser–Meyer–Olkin measure of sampling adequacy value of 0.917 (Hair et al., 1998). The Bartlett Test of Sphericity was significant [$\chi^2 = 4659.882$, $P < 0.001$], indicating that correlations existed between some of the response categories. Those eigenvalues greater than one were used to determine the number of factors in each data set (Churchill, 1991). The nine key dimensions identified accounted for approximately 69 percent of the total variance.

Table 2 Exploratory factor analysis for GSCM attributes

GSCM attributes	Factor loading
Green policy (Explained variance=3.70%)	
G1: My company has a clear environmental policy statement	0.725
G2: My company managers have a commitment to and support for GSCM	0.835
G3: Cross-functional cooperation works well for GSCM in my company	0.553
Green shipping (Explained variance=3.17%)	
G4: ISO 14000 series are well performed in my company	0.535
G5: Adopt environmental-friendly design of shipbuilding (e.g. improved engine design, waste heat recovery systems, double skin and internal oil tank)	0.670
G6: Use environmental-friendly materials and equipments (e.g. non-toxic paint, electric deck machine, ballast water handling system)	0.696
G7: Use clean-burning, low-sulphur fuels in their main and auxiliary engines	0.514
Green marketing (Explained variance=28.42%)	
G8: Provides customers with environmental-friendly service information.	0.677
G9: Plans to spend more budget on green advertising	0.721
G10: Adopts resource and energy conservation arguments in marketing	0.816
G11: Undertakes periodic updating of the website on environmental issues	0.692
G12: Attracts customers with green initiatives and eco-services	0.798
Green collaboration with supplier (Explained variance=6.01%)	
G13: Achieving environmental common goals collectively	0.689
G14: Developing a mutual understanding of environmental risk and responsibilities	0.739
G15: Working together to reduce environmental impact of our service activities	0.777
Green collaboration with partner (Explained variance= 4.77%)	
G16: Achieving environmental common goals collectively	0.798
G17: Developing a mutual understanding of environmental risk and responsibilities	0.801
G18: Working together to reduce environmental impact of our service activities	0.665
Green collaboration with customer (Explained variance=4.85%)	
G19: Achieving environmental common goals collectively	0.683
G20: Developing a mutual understanding of environmental risk and responsibilities	0.685
G21: Working together to reduce environmental impact of our service activities	0.633

Table 3 Exploratory factor analysis for Environmental performance and firm competitiveness attributes

Environmental performance and firm competitiveness attributes	Factor loading
Reduction of pollutant (Explained variance=4.20%)	
P1: Reduction of air emission (e.g. CO2, SOx, NOx…)	0.614
P2: Reduction of waste water (e.g. sewage)	0.640
P3: Reduction of noise pollution	0.777
P4: Reduction of wastes (e.g. oily waste, sludge and rubbish)	0.678
Decrease of cost (Explained variance=10.08%)	
P5: Decrease of cost for materials purchasing	0.834
P6: Decrease of cost for energy consumption	0.801
P7: Decrease of cost for disposal of hazardous materials	0.749
P8: Decrease of cost for waste treatment	0.825
Improved competitiveness (Explained variance=6.74%)	
P9: Improved company's service quality assurance	0.732
P10: Improved company's market competitiveness	0.814
P11: Improved company's profitability	0.848

Table 4 Results of reliability test

Measures	Items	Mean	S.D.	Cronbach α	CITC range
Green policy	3	4.14	0.74	0.79	0.56 — 0.69
Green shipping practice	4	4.33	0.82	0.81	0.54 — 0.76
Green marketing	5	4.02	0.93	0.87	0.57 — 0.78
Green collaboration with supplier	3	4.16	0.85	0.83	0.64 — 0.77
Green collaboration with partner	3	4.14	0.76	0.81	0.64 — 0.67
Green collaboration with customer	3	4.10	0.96	0.82	0.66 — 0.70
Reduction of pollutant	4	4.22	0.85	0.75	0.55 — 0.60
Decrease of cost	4	3.84	0.78	0.86	0.64 — 0.78
Improved competitiveness	3	4.23	0.93	0.87	0.70 — 0.76

In this study, a rigorous process was used to develop and validate the survey instrument, modeled on previous empirical studies. Prior to data collection, content validity was supported by previous literature and executive interviews. After the data collection, a series of analyses was performed to test the reliability and validity of the constructs. Exploratory factor analysis (EFA), using principal components extraction with varimax rotation, was employed derive the underlying dimensions of GSCM, environmental performance, and firm competitiveness since measurement items were adopted from different sources. Results revealed that measurement items all had strong loading on the construct (see Table 2 and table 3). The generally agreed lower limit for

Cronbach's alpha is 0.60 (Flynn et al., 1990; Nunnally, 1994). Cronbach alpha values in Table 4 indicate that all constructs are reliable for this research (Nunnally, 1978). In addition, we used the corrected item-total correlation (CITC) reliability test (Kerlinger, 1986). Table 4 also shows that all CITC values were larger than 0.50, which is higher than the minimum acceptable value of 0.30. Based on the Cronbach's alpha values and CITC values, we conclude that the scales are reliable.

4.3. Cluster Analysis Results

The 163 firms of respondents were categorized into four groups based on their factor means in GSCM dimensions from factor analysis using two-stage cluster analysis techniques. Forty-one were assigned to Group 1, 36 to Group 2, 42 to Group 3, and 44 to Group 4. Canonical discriminant functions (Klecka, 1980) demonstrated the nature of segment differences, and explained 100 percent of the variance.

4.4. Interpretation of Clusters

ANOVA and a Scheffe test were used to examine whether the GSCM dimensions differed among the four groups. Table 5 shows ANOVA test results in terms of factor means. All six GSCM dimensions were found to differ significantly among the four groups at the $p < 0.05$ significance level.

Table 5 One-way ANOVA of GSCM differences among the four groups

Dimensions	Groups				F	F	Scheffe Test
	1(41)	2(36)	3(42)	4(44)	Value	Prob.	
Green policy	4.00	**4.44**	**4.76**	3.63	71.92	0.00***	(1,2)(1,3)(1,4)(2,3)(2,4)(3,4)
Green shipping	3.99	**4.15**	**4.70**	3.30	79.48	0.00***	(1,2)(1,3)(2,3)(2,4)(3,4)
Green marketing	3.88	**4.21**	**4.48**	2.97	96.01	0.00***	(1,2)(1,3)(1,4)(2,3)(2,4)(3,4)
GCWS	**4.63**	3.86	**4.45**	3.40	84.88	0.00***	(1,2)(1,4)(2,3)(2,4)(3,4)
GCWP	**4.24**	3.90	**4.56**	3.85	25.97	0.00***	(1,2)(1,3)(1,4)(2,3)(3,4)
GCWC	**4.30**	3.86	**4.61**	3.42	47.05	0.00***	(1,2)(1,3)(1,4)(2,3)(2,4)(3,4)

Note: ***significant at $p < 0.001$, GCWS= Green collaboration with supplier, GCWP= Green collaboration with partner, GCWC= Green collaboration with customer

As shown in Table 5, a comparison of factor means shows Group 1 had its highest means on the green collaboration with supplier (GCWS), green collaboration with partner (GCWP), green collaboration with customer (GCWC) dimensions, followed by the green marketing, green policy, and green shipping practice dimensions. Group 2 had its highest means on the green policy and green shipping practice dimensions but had lower factor means on the green collaboration with supplier (GCWS), green collaboration with partner (GCWP), green collaboration with customer (GCWC) dimensions. Group 3 had its highest means on the green policy, green shipping, green collaboration with customer (GCWC) dimensions, green collaboration with partner (GCWP), followed by the green marketing, and green collaboration with supplier (GCWS) dimensions. Group 4 had its highest factor means on the green collaboration with partner (GCWP) and green policy. It had its lowest factor means, however, on the green marketing dimension. From cluster analysis, four groups emerged that were based on the GSCM dimensions, namely, a external green oriented group (EGOG), a internal green oriented group (IGOG), a high internal and external green oriented group (HIEGOG), and a low internal and external green oriented group (LIEGOG). It is interesting to note that it was a broad dividing line in GSCM capabilities between members of group 1 (EGOG) and 2 (IGOG) compared to members of group 3 (HIEGG) and 4 (LIEGG). A closer look at the mean scores (see Table 5) reveals that there are several empirical findings between group 1 and 2. First, members of group 1 is more external GSCM highlighted than members of group 2, but less internal GSCM highlighted than members of group 1. Second, the results also indicated that group 2 (IGOG) had better environmental performance and firm competitiveness with respect to reduction of pollutant (ROP) and decrease of cost (DOC) than group 1 (EGOG) and group 4 (LIEGOG), but group 1 (EGOG) had better environmental performance and firm competitiveness with respect to improved competitiveness.

Table 6 One-way ANOVA of environmental performance and firm competitiveness differences among the four groups

	Groups				F Value	Comparison	Scheffe Test
	1(41)	2(36)	3(42)	4(44)			
ROP	**4.13**	**4.30**	**4.68**	3.96	177.76***	3>2>1>4	(1,2)(1,3)(1,4)(2,3)(2,4)(3,4)
DOC	3.75	3.84	**4.69**	3.18	35.46***	3>2>1>4	(1,3)(1,4)(2,3)(2,4)(3,4)
IC	**4.33**	3.91	**4.79**	3.73	58.27***	3>1>2>4	(1,2)(1,3)(1,4)(2,3)(3,4)

Note: ***significant at $p < 0.001$, ROP= Reduction of pollutant, DOC= Decrease of cost, IC=Improved competitiveness

A one-way ANOVA was used to test differences in environmental performance and firm competitiveness among the four groups on the basis of Scheffe tests. Respondents were also asked to provide information relating to their firm's performance in terms of the degree of reduction of pollutant (ROP), decrease of cost (DOC), and improved competitiveness (IC). Overall, the high internal and external green oriented group (HIEGOG) had a better environmental performance and firm competitiveness (i.e., ROP, DOC, and IC) than the other three groups. The empirical findings also indicated that the internal green oriented group (IGOG) had better environmental performance and firm competitiveness with respect to reduction of pollutant (ROP) and decrease of cost (DOC) than the external green oriented group (EGOG) and the low internal and external green oriented group (LIEGOG). The external green oriented group (EGOG) had better environmental performance and firm competitiveness with respect to improved competitiveness (IC) than internal green oriented group (IGOG) and low internal and external green oriented group (LIEGOG).

5. CONCLUSION AND LIMITATIONS

This paper investigated crucial green supply chain management (GSCM), environmental performance and firm competitiveness dimensions based on global container shipping service. In addition, the study offers an alternative approach to test the RBV theory of green supply chain management. On the basis of a factor analysis, six GSCM dimensions: green policy, green shipping practice, green marketing, green collaboration with supplier, green collaboration with partner, green collaboration with customer, and three environmental performance and firm competitiveness dimensions: reduction of pollutant, decrease of cost, improved competitiveness were identified. Based on this foundation, container shipping companies can achieve stable economic and environmental performance. According to their factor means in the GSCM dimensions, a cluster analysis subsequently assigned responding firms into four groups, namely, the external green oriented group (EGOG), the internal green oriented group (IGOG), the high internal and external green oriented group (HIEGOG), and the low internal and external green oriented group (LIEGOG). Members of group 3 (HIEGOG) generally rated both internal GSCM and external GSCM higher than members of group 1 (EGOG), 2 (IGOG), and 4 (LIEGOG). The empirical evidence relating the extent of internal GSCM capabilities, external GSCM capabilities with environmental performance and firm competitiveness supports the contention that internal GSCM capabilities can lead to cross-functional departments green cooperation resulting in reduction of pollutant, and external GSCM capabilities can lead to inter-organizational green collaboration with supplier, partner, and customer resulting in reduction of pollutant and improved competitiveness. The findings also provide policy implications for the International Maritime Organization (IMO) in supporting GSCM capabilities in container shipping industry. The results of this investigation are also useful for maritime shipping operators that have invested or plan to invest in GSCM, especially in the container shipping industry examined by this study. To achieve green performance and enhance firm competitiveness container shipping operators must implement strategies that involve the abovementioned internal and external GSCM parameters. This study suggests that container shipping managers could develop strategic green collaboration with their partners such as terminal operators, freight forwarders, inland transport operators, and shippers in order to maintain reliable global collaboration and integrated services and foster their green performance. The results of this study also support the broad contention that container shipping firms should focus on strengthening green supply chains through cross-functional intra-firm and inter-firm collaboration with suppliers, customers, and partners. Thus, for both conceptual and empirical reasons, this paper evaluated the relationship between internal/external GSCM capabilities and environmental performance and firm competitiveness is both timely and potentially of great value.

While the objectives of the study were successfully accomplished, several limitations of the present study should be noted. Future studies could be conducted to address these limitations. First, in this study, the data collection was restricted to container shipping companies in Taiwan. A different sample should be employed from other industries or different countries to further confirm the findings. Second, this study only focused on the relationships between GSCM capabilities and environmental performance and firm competitiveness. A number of determinants of GSCM and environmental performance and firm competitiveness could be considered in the future study including organizational climate and cultural factors (e.g., entrepreneurial and learning orientation; Deshpande and Farley, 2004). Third, from a methodological perspective, it would be helpful to consider alternative methodological approaches to test the relationships between variables. A hierarchical regression analysis might also be a good method to identify the significant GSCM factors relating to environmental performance and firm competitiveness dimensions. Fourth, similar to most empirical studies that have been conducted in the past, this study also examines a 'snapshot image' of green supply chain management. Future research may also be conducted by using the longitudinal approach to investigate the short- and long-term effects of GSCM on environmental performance and firm competitiveness of container shipping operations to further confirm the results proposed in this paper. Finally, self-reported data on environmental performance and competitiveness by the questionnaire may have been subject to bias in terms of respondents' willingness to respond and report accurately. Hence, further research might measure environmental performance and competitiveness by actual data.

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