African Journal of Business Management Vol. 6(4), pp. 1475-1482,1 February, 2012
Available online at http://www.academicjournals.org/AJBM
DOI: 10.5897/AJBM11.2071
ISSN 1993-8233 ©2012 Academic Journals

Full Length Research Paper

Green management of logistics enterprises and its sustainable performance in Korea

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Accepted 24 October, 2011

Sustainability is a major subject of interest in the field of business and environmental management. Many previous studies have emphasized the trade-off between economic activities and their negative effects on the environment. Moreover, previous studies have focused principally on manufacturing enterprises; however, only a few studies conducted thus far have concerned themselves with the logistics sector. This study fills these gaps by testing the causal relationship between proactive green management and the sustainable performance of logistics enterprises in Korea. Additionally, as compared with previous literature that discusses the partial relationship between environmental variables and firm performance, this study synthesizes the factors of green awareness and green strategy that may affect green logistics management, based on a total systematic structural equation model (SEM). SEM has advantages in examining the causal relationship between green logistics practice and business performance. Our results demonstrate the positive impact of green awareness and green logistics practice on logistics performance, whereas the influence of green strategy on logistics performance is apparently not significant.

Key words: Green logistics management, green awareness, business performance, structural equation modeling (SEM), Korean transport enterprises.

INTRODUCTION

As the global economy integrates countries across the world, the paradigm shift from manufacturing to assembling has put an increased focus on the importance of logistics. In the era of cooperative business by assembling, businesses have learned to co-function with multiple partners. Thus, logistics has been used extensively to describe collaborative practices among networks of transportation, storage, and handling of products as they move from material sources through the supply chain system to the final point of sale or consumption, which is the key determinant of business performance (Choi, 2011).

After the Kyoto Protocol took effect on February 16, 2005, worldwide environmental issues have pressurized governments into reducing negative environmental impact; this has encouraged enterprises to implement eco-friendly activities. According to a previous OECD report (2010), the transport sector is a significant contributor to overall greenhouse gas (GHG) emissions. With regard to CO_2 emissions, the transportation sector accounts for roughly 24%, which is slightly more than the manufacturing sector. In particular, the rate of CO_2 emissions growth from the transportation sector in Korea appears to be much more rapid than in other OECD countries. The amount of increase in CO_2 emissions of this sector is approximately twice that of the OECD average (OECD Report, 2010). This implies that transportation companies have attempted to maximize their profits, but do not pay a great deal of attention to the environmental impact. However, the Korean government has strongly promoted its 'green growth paradigm' for the enterprises to utilize the eco-friendly opportunities. In order to achieve the objective of green growth policy, it is necessary to strike a balance among environmental, economic, and social performance.

Prior to the 1980s, initiatives for logistics enterprises were typically temporary and passive in response to government regulations. Recently, public concern began

to increase over environmental issues, and new international standards were introduced, including ISO 14001 and ISO 26000, in order to accredit enterprises' green practices. Customers gradually became more sensitive as to whether suppliers had the required environmental accreditations. As Murphy and Poist (1995) indicated in their survey studies, 61% of U.S. firms had formal or written environmental strategies by 1995. Thus, if enterprises plan to extract more value by adopting green management strategies, they must clearly institute additional environmental management strategic elements to ensure favorable business performance.

Green logistics is a relatively young but rapidly evolving field. In fact, Aronsson and Brodin (2006) have determined that only 2.2% of papers related to logistics addressed environmental issues. Even if many enterprises set off the green awareness movement by incorporating corporate social responsibility (CSR) programs into their business plans, they continue to lack integrated practices in terms of green logistics networks. With increasing concern about integrated practices on green logistics, now is the time to answer the question as to whether there is indeed a trade-off between green logistics practice and business performance. Will firms who pay more attention to the practice of green logistics achieve greater environmental performance? This question is not new, and similar efforts have been made to assess empirically the relationship between green management practices on business performance (He et al., 2009; Lee, 2009; Chang and Fong, 2010; Choi and Zhang, 2011). Our paper extends this approach to the field of logistics enterprises as the network manager of all manufacturing processes.

Previous studies have suffered from some limitations, as follows. First, previous literature has emphasized only a partial relationship between green management and its performance. For instance, some studies have analyzed a direct relationship between environmental management and environmental performance (Szymanski and Tiwari, 2004; Zhu and Sarkis, 2004). Other studies have assessed the causality between environmental management and financial performance (Wagner et al., 2002; Wagner, 2005). This paper integrates these two factors into a more comprehensive model. The paper will include an assessment of the total effect between the environmental and business variables, as well as their performance. Environmental (green) awareness and a proactive green strategy were integrated into the model to evaluate the relationship between these physical and practical issues of green management and its sustainable performance. Moreover, sustainable performance includes information regarding financial performance as well as environmental performance.

Second, while previous studies have focused primarily on manufacturing enterprises with general environmental variables, only a few studies have researched the logistics sector with special green logistics management variables. This paper fills this gap, to analyze the relationship between green logistics management and its performance in the logistics sectors of Korea. Third, most studies conducted thus, far into this set of issues have been based on regression analyses in their methodological approaches. Even if this direct causality explains the role of green issues readily and clearly, it still lacks the integrated multi-dimensional or step-wise implication of the empirical results. Therefore, this paper introduces the structural equation model (SEM) to correct this methodological bias.

The more field-oriented empirical question is whether improved environmental management could result in better business performance. A large body of literature has been devoted to empirically testing the link between green management and business performance. However, no general consensus has been reached in this regard (Zeng et al., 2010). Some authors have argued that proactive environmental management is simply a tool to help enterprises achieve better business performance, which creates a positive relationship (Huang and Shih, 2010; Wu et al., 2010; Lee and Kim, 2009). By placing more emphasis on environmental management, enterprises may reduce costs and increase revenues (Ambec and Lanoie, 2008).

Other studies, however, have concluded that environmental practices and initiatives involve greater costs and fewer benefits, and may even result in the formation of a negative relationship between environmental management and business performance (Cordeiro and Sarkis, 1997; Wagner, 2005). These sorts of contradictory conclusions may derive from different sets of variables and/or the methodological bias. Most studies have employed multiple regression analysis to assess the relationship, and multiple regression analysis provides only simple and partial information. Additionally, all studies conducted thus far have focused principally on environmental management in general, particularly in manufacturing industries. None of the studies have touched on green logistics issues in manufacturing collaboration networks.

To synthesize all of these approaches and fill in the relevant gaps, the structural equation modeling (SEM) is introduced to analyze the causal relationship between green logistics management and the business performance of logistics enterprises in Korea. The SEM technique involves multiple regression analysis, path analysis, and confirmatory factor analysis (Hussey and Eagan, 2007). SEM employs both structure equations and measurement equations. The structure equations depict the relationships among the latent variables, which can be used to derive the qualitative relationship between exogenous and endogenous variables in multiple regression analysis. The measurement equations map the relationship between the latent variables and observable variables via confirmatory factor analysis (CFA) (Chen and Li, 2010) (Appendix).

Table 1. Descriptive statistics and correlations of latent variables.

Variable	Mean	Std. dev.	Awareness	Strategy	Management	Performance
Awareness	3.587	1.631	1.000			
Strategy	4.015	1.524	0.859*	1.000		
Management	4.720	1.193	0.709*	0.780*	1.000	
Performance	4.452	1.235	0.733*	0.684*	0.792*	1.000

*. Correlation is significant at the 99% level (2-tailed).

HYPOTHESES AND MODEL

Based on a comparison with the results of previous research studies as shown in Table 1, we discuss the various research hypotheses and models subsequently.

Green awareness and green strategy hypothesis

If an enterprise has green logistics awareness, then it can be readily grasped that the enterprise may also need a proactive green logistics strategy and green logistics practices. As some authors have previously indicated, green awareness is the key element of a green strategy. López-Gamero et al. (2010) found that if environmental strategies are not driven by legislation, but rather driven by green awareness, their effect on environmental management is significantly positive. Hart and Ahuja (1996) demonstrated that firms with an early awareness may be opting for more advanced environmental low emissions strategies. Sarkis (2006) demonstrated that enterprises that develop an early pollution-reducing processing equipment strategy benefit from higher profit growth than later followers. This implies that firms implemented green awareness into better environmental programs, and strategies will have better environmental performance. These concepts allow for the formulation of the following hypotheses:

H_1: There is a positive relationship between green logistics awareness (GA) and green logistics strategy (GS).
H_2: Green logistics awareness (GA) has a positive effect on green logistics management (GM).
H_3: Green logistics awareness (GA) has a positive effect on business performance of logistics (LP).
H_4: Proactive green logistics strategy (GS) has a positive influence on green logistics management (GM).
H_5: Proactive green logistics strategy (GS) has a positive influence on business performance of logistics (LP).

Green logistics management hypothesis

As discussed previously, an extensive body literature has assessed the relationship between green management and business performance; however, these studies have yielded no conclusive results. Although, the results have been mixed, research has predominantly supported the existence of a positive relationship between “green management” (not green logistics) and performance. Interestingly, all studies published after the year 2005 evidenced a positive relationship. Thus, as green issues become increasingly critical in the logistics industry, green logistics management is a key element to help enterprises extract greater value. In light of these factors, we propose the following hypothesis:

H_6: Green logistics management (GM) has a positive impact on business performance of logistics (LP).

Insights into these hypotheses provide us with a basis for making inferences regarding the relationship among those variables, as shown in Figure 1.

METHODOLOGY

Here, we will discuss the sample and data collection, variable measurements, and methods for the construction of the structural model.

Sample and data collection

Our sample and data was collected via face to face or telephone interviews, fax and e-mail questionnaires; the respondent was instructed to focus on the staff, section chief, and manager of the logistics enterprise, which is a member of the KTA (Korea trucking association). The KTA represents the only leading group of logistics companies in Korea. This questionnaire was initially disseminated in February 2011, and completed in April 2011. A total of 156 copies of the questionnaires were collected and 129 copies of the questionnaires provided all of the information required (these questionnaires came from different areas of South Korea). The 129 logistics enterprises represent the various kinds of operational areas: 23.3% are in the integrated logistics sector, 60.5% in the transportation sector, 5.4% in the storage sector, 6.0% and 4.7% in the loading and unloading sector, 1.6% in the logistics forwarding sector, 3.1% in the delivery sector, and the rest in other logistics sectors. It is important to deal with the potential problem of a non-response bias. To deal with this issue, we tested for a non-response bias using a comparison of early and late respondents as recommended by Armstrong and Overton (1977). The 129 questionnaires were divided into two groups based on their completion date. A t-test is used to determine whether there were any differences in the answers between the early and late groups.

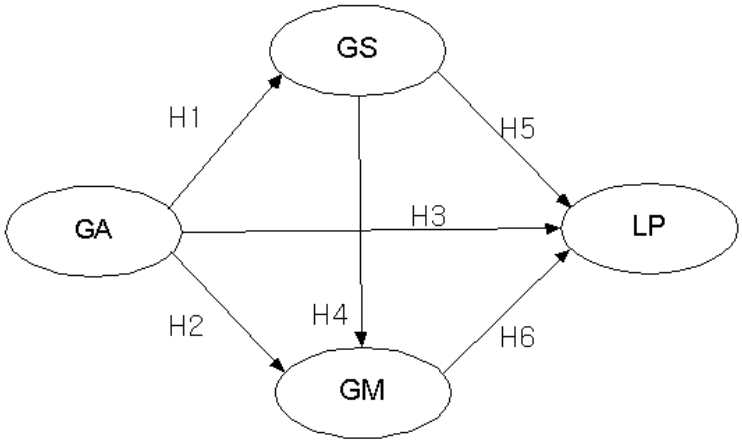

Figure 1. Research hypotheses and structural model.

Table 2. Reliability and validity test by the Cronbach's alpha and CFA.

Variable	Cronbach α	χ^2/df (p)	GFI	NFI	CFI	RMSEA
Green awareness	0.954	1.827 (0.12)	0.932	0.972	0.973	0.071
Green strategy	0.968	1.703 (0.18)	0.946	0.973	0.976	0.066
Green management	0.974	1.928 (0.11)	0.952	0.974	0.984	0.080
Logistics performance	0.957	2.015 (0.15)	0.910	0.962	0.966	0.079
Recommended criteria	> 0.7	< 3 (> 0.05)	> 0.9	> 0.9	> 0.9	< 0.08

The results indicated that there were no significant differences in various items between the two groups; these results indicate that non-response bias was not a problem in this study.

Measurement of the latent variables

Green logistics awareness (GA)

In accordance with the guidance of authors including López-Gamero et al. (2010), we used 6 items (ga1-ga6) to evaluate green logistics awareness in terms of self-perception of the firms' managers, including awareness of the government's green policies, mindfulness of being "green", knowledge about being "green", the behavior of staff, "green" standardization, and "green" training. Each item is measured on a 7-point Likert response scale (1 = strongly disagree, 7 = strongly agree).

Green logistics strategy (GS)

According to Zhu et al. (2005), 9 items (Gs1 to Gs9) are used to measure the green logistics strategy of firms. Some of the items included strategies regarding standardization, infrastructure, emissions reduction, technological management, and sustainability. They were also measured using a 7-point Likert scale.

Green logistics management (GM)

Green logistics management refers to detailed eco-friendly logistics practices on diverse types of logistics process. Although, many previous studies have used various variables for eco-friendly management, no study yet conducted has laid out specific measures for green 'logistics' management. In this study, 20 detailed items were selected in relation to different logistics processes. These items included information sharing (m_1 to m_3), packing (m_4 to m_6), warehousing (m_7 to m_9), distribution (m_{10} to m_{12}), loading and unloading (m_{13} to m_{14}), logistics networking (m_{15} to m_{17}), and emissions reduction (m_{18} to m_{20}). We used a 7-point Likert scale to measure the items.

Business performance of logistics (LP)

Previous studies have focused solely on environmental performance (Szymanski and Tiwari, 2004; Zhu and Sarkis, 2004) or on financial performance (Wagner et al., 2002; Wagner, 2005; Zeng et al., 2010). In this paper, we integrate both items, including environmental performance ("green" image gain and "green" service level-up) and financial performance (sales increase and energy cost reduction) to represent sustainable performance using the variable of logistics performance (LP). Table 1 shows the descriptive statistics and correlations of the four latent variables. Since each of the correlations of the five variables is smaller than the corresponding calculated Cronbach's alpha coefficients shown in Table 2, the composite index of variables are deemed acceptable for further analysis (López-Gamero et al., 2009).

RESULTS AND DISCUSSION

Reliability and validity

The proposed model must be statistically reliable and

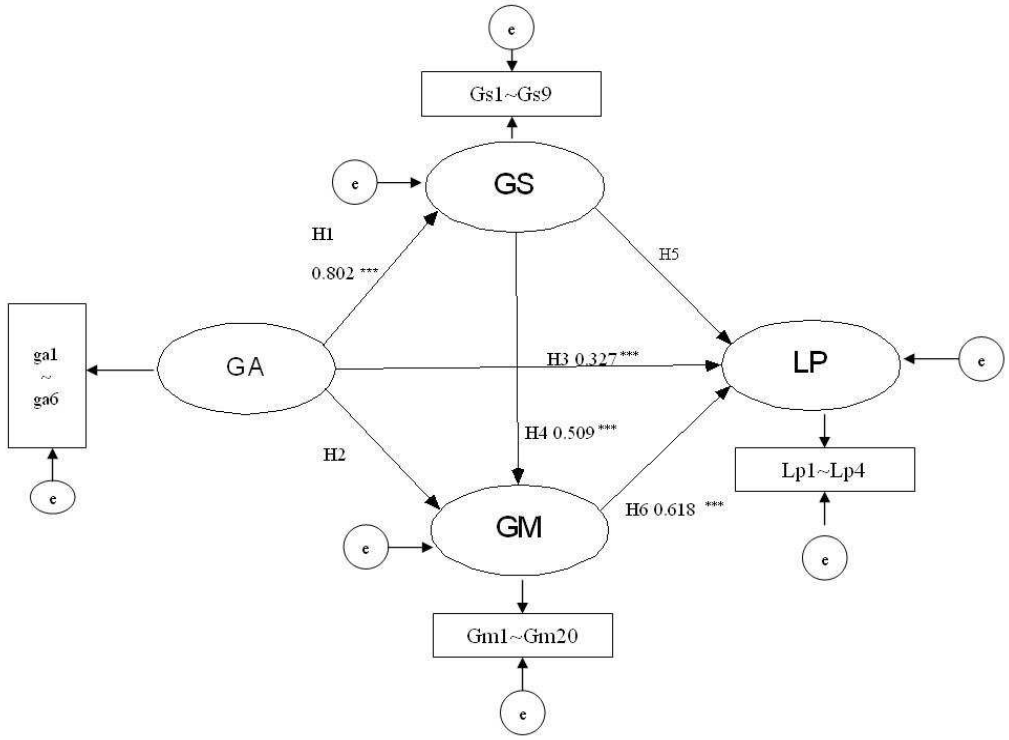

Figure 2. Path coefficients in a structural equation model.

valid, and thus reflective of reality. It must also be ensured that the statistical results are meaningful. A positive result for the reliability test implies that the proposed method generates similar results when carried out again under the same conditions. For the reliability test, we used the Cronbach's alpha coefficient, which is the most commonly used criterion for reliability measurements.

Validity refers to the extent to which items reveal true information. A confirmatory factor analysis (CFA) is one of the most effective tools for validity testing (Zeng et al., 2010). SPSS 17.0 and AMOS 17.0 were used to assess reliability and validity, respectively. The results are shown in Table 2. In the reliability measurements, the Cronbach's Alpha coefficients were bigger than the suggested criteria, 0.7, and for the validity test, the CFA measures, such as χ^2/df (p), GFI (goodness-of-fit index), NFI (normalized fit index), CFI (comparative fit index), and RMSEA (root mean square error of approximation) all exceeded the recommended criteria. This indicates that the reliability and validity of the data are good for the empirical test.

Hypotheses test results

The AMOS 17.0 package was employed to run our structural equation modeling using the maximum likelihood (ML) approach. The overall fitness of the SEM was assessed using the same set of goodness-of-fit indices as were used for the confirmatory factor analysis; $\chi^2/df=2.129$, *GFI, NFI, and CFI* are all bigger than 0.9, thus, suggesting that the SEM adequately fits the data. All of the SEM modeling and path coefficients are shown in Figure 2 and Table 3. With regard to green awareness (GA), the results show that GA is significantly positively related ($p < 0.01$) to green strategy (GS), thus supporting H_1; however, GA is not related with green logistics management (GM). However, there is a positive relationship between green awareness (GA) and logistics performance (LP), thus supporting H_3. With regard to green strategy (GS), the results demonstrate that green strategy has a significantly positive effect on green management (GM) ($p < 0.01$), thus supporting H_4, but has no significant impact on logistics performance, thus rejecting H_5. Finally, there is a significant positive relationship between green management (GM) and logistics performance (LP) ($p < 0.01$); thus, H_6 is accepted.

DISCUSSION AND MANAGERIAL IMPLICATIONS

With regard to green awareness and strategy, the results show that green logistics awareness exerts a significant effect on green logistics strategy (H1). However, it has no

Table 3. Results of the hypotheses test.

Path relationship			Path coefficient	S.E.	C.R.	P	Hypotheses	Results
GS	<---	GA	0.802	0.043	6.792	***	H_1	Accept
GM	<---	GA	0.110	0.079	1.397	0.165	H_2	Reject
LP	<---	GA	0.327	0.074	4.421	***	H_3	Accept
GM	<---	GS	0.509	0.084	6.035	***	H_4	Accept
LP	<---	GS	-0.116	0.089	-1.297	0.197	H_5	Reject
LP	<---	GM	0.618	0.083	7.443	***	H_6	Accept

*** means $p < 0.01$.

significant impact on green logistics management (H_2). The green logistics strategy exerts a significant effect on green logistics management, thus confirming H_4; however, it has no direct significant effect on logistics performance, rejecting H_5. These results show that green awareness does not have a direct effect on green management, but does have an indirect effect on green management via its effect on green strategy (H_1 and H_4 are supported). The empirical results indicate that green awareness only cannot result in field-oriented green logistics practices in the enterprise; thus the Korean government should promote environmental policies for logistics enterprises in order to enhance green logistics management. These implications are consistent with the results of studies by Hitchens et al. (2003) and López-Gamero et al. (2010), in that green awareness conferred by fiat of government legislation has a positive effect on environmental strategy.

Sarkis (2006) indicated that an early strategy for pollution-reducing processing equipment offers more benefits, with a higher profit growth, than late follower companies. However, the findings in Table 3 indicate that the green strategy did not evidence a direct effect on logistics performance, but an indirect effect via its effect on green management (H4 are H6 are significant). This implies that planning or strategies only cannot lead to environmental benefits. The only factor that directly influences the logistics performance is the practice of green management.

The results demonstrate the existence of a significant positive relationship between green logistics management and logistics performance, thus confirming H_6. Our findings coincide with Rao and Holt (2005) and Wu et al. (2010), whereas the findings disagree with the findings of Cordeiro and Sarkis (1997). Rao and Holt (2005) suggested that enterprises with green supply chains may achieve substantial cost savings, enhance sales, and exploit new market opportunities, thereby resulting in a better business performance. Wagner (2005) also shows that high levels of environmental performance are possible only if the enterprise's green management has a proactive technological pollution orientation. The results provided in Table 3 imply that from the empirical evidence gathered from logistics enterprises in Korea, it is necessary that green logistics practices be adopted as a key element in their business and supply chain models, in order to extract more value and enjoy better logistics performance. These results also imply that the role of government promotion policies for green logistics is much more important for logistics enterprises to mold their strategies on the basis of induced awareness (Choi and Lee, 2009).

Conclusion

Previous studies of green management and its performance have focused principally on manufacturing enterprises; these studies have focused solely on the partial relationship of the dichotomy between the business and the environment. The principal objective of this study was to contribute to current literature by introducing a synthetic model based on structural equation modeling to evaluate the causal relationship between the green logistics management and business performance of the logistics sector in South Korea.

In this paper, we determined that green awareness has a significant positive relationship with green strategy, but has no relationship with green management; this suggests that green awareness needs to be systematically integrated into the green logistics practices of the enterprise. This implies that Korean logistics enterprises are generally in the initial stage of green logistics management, because even though they are aware of the importance of green logistics, they are reluctant to apply these ideas to their business practices at this time.

Therefore, the government must promote eco-friendly policies for the advanced logistics industry. Additionally, our results demonstrate that green strategy has a significant positive effect on green logistics management, and that there is a significantly positive relationship between green logistics management and firm logistics performance as well. It shows the spirit of strong pragmatism among the Korean enterprises, thereby indicating that green logistics practices are the key element for the logistics enterprises to extract more value and to enjoy better business competitiveness.

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APPENDIX 1

Table 1. Measures of observed variables

Green awareness items		Factor loadings	Mean
Your firm follows government policy on green logistics actively		0.904	3.867
The managers of firm pay close attention to green logistics		0.906	4.051
The managers of firm have a good knowledge on green logistics such as carbon footprint		0.917	4.143
The staff has a good awareness of green logistics		0.907	4.173
The firm follows green standardization well such as ISO 14001 and GRI guidelines		0.851	4.296
The firm pays close attention to green training for employees		0.758	4.061
Green strategy items		**Factor loadings**	**Mean**
Your firm takes great effort on logistics standardization		0.867	4.194
The firm takes effort on plan of green infrastructure		0.921	4.204
The firm takes effect on strengthening green infrastructure		0.926	4.265
The firm takes effort on control of pollution sources in logistics activities		0.945	4.143
The firm plans Integrated distribution		0.862	4.235
The firms takes great effort on logistics technological research		0.912	4.194
The firms takes great effort on technological standardization in logistics		0.837	4.357
The firms take many activities in logistics standardization		0.858	4.306
The firms take great effort on green marketing and green business ma-nagement		0.939	4.214
Green management items		**Factor loadings**	**Mean**
Information sharing	The firm shares information with manufacturing firms and retailers well	0.895	4.153
	The firm makes great effort on efficient and accurate ordering system	0.929	4.439
	The firm takes effort on outsourcing to cut costs	0.868	4.286
Packing	The firm use green packing materials	0.931	4.357
	The firm follows packing standardization	0.862	4.418
	The firm makes effort on reducing packing material amount	0.928	4.357
Warehouse	The firm emphasizes warehouse's efficient management	0.903	4.653
	The firm emphasizes the reduction of warehouse fee	0.895	4.673
	The firm emphasizes the location selection of warehouse	0.929	4.602
Transportation	The firm pushes the standardization of transport	0.868	4.786
	The firm tries to optimize the routing of vehicles	0.931	4.633
	The firm tends to select greener vehicles and greener transport modes such as shipping and air	0.862	4.306
Loading and unloading	The firm focuses on loading and unloading efficiently	0.928	4.276
	In order to improve efficiency, the firm considers the container or pallet	0.903	4.480
Logistics networking	The firm pays attention to construction of logistics networking	0.895	4.571
	The firm emphasizes information technology input and usage	0.929	4.520
	The firm pays attention to efficient logistics information network	0.862	4.531
Logistics emissions	The firm tries hard to reduce the pollution emissions in logistics activities	0.928	4.388
	The firm takes great effort to reduce green house gas (GHG)	0.903	4.367
	The firm takes great effort to save energy costing	0.863	4.388
Business performance items		**Factor loadings**	**Mean**
Financial performance: Through green logistics management, cost decreases as a result of energy savings		0.932	4.306
Financial performance: Return on Sales is significantly increased through green logistics management		0.939	4. 402
Environmental performance: The green brand image is increased by green logistics management		0.951	4.312
Environmental performance: Green service satisfaction level improved by green logistics management		0.921	4.421