Journal of Technology Management & Innovation

E-ISSN: 0718-2724

ljimenez@jotmi.org

Universidad Alberto Hurtado

Chile

Lin, Chieh-Yu; Ho, Yi-Hui

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Journal of Technology Management & Innovation, vol. 3, núm. 1, 2008, pp. 17-26

Universidad Alberto Hurtado

Santiago, Chile

J. Technol. Manag. Innov. 2008, Volume 3, Issue 1

Journal of Technology Management & Innovation

Received March 16, 2008 / Accepted March 31, 2008

AN EMPIRICAL STUDY ON LOGISTICS SERVICE PROVIDERS' INTENTION TO ADOPT GREEN INNOVATIONS

Chieh-Yu Lin
Associate Professor, Department of International Business
Chang Jung Christian University
396, Sec.1, Chang Jung Rd., Kway Jen, Tainan, 71101, Taiwan
Tel: 886-6-2785123 ext 2154
Fax: 886-6-2785662
E-Mail: jylin@mail.cjcu.edu.tw

Yi-Hui Ho
Assistant Professor, Department of International Business
Chang Jung Christian University
396, Sec.1, Chang Jung Rd., Kway Jen, Tainan, 71101, Taiwan
Tel: 886-6-2785123 ext 2158
Fax: 886-6-2785662
E-Mail: vicky@mail.cjcu.edu.tw

Abstract

This study examines six factors that will influence the intention to adopt green innovations for logistics service providers. The determinant factors include technological, organizational and environmental dimensions. The data came from the questionnaire survey on logistics companies in Taiwan, and 162 samples were analyzed. According to the survey results, all the factors have positive influences on the intention to adopt green practices. Explicitness and accumulation of green practices, organizational encouragement, quality of human resources, environmental uncertainty and governmental supports exhibit significant influences on the willingness to adopt green practices.

Keywords: Green innovation, Logistics service providers, Determinants of Innovation, Technology adoption

Introduction

There is a remarkable increase in both interests and reactions to the concept of preserving the environment in recent years. The Nobel Peace Prize committee has turned its sights on the battle against climate change by giving the 2007 award to former US vice president Al Gore and the Intergovernmental Panel on Climate Change (IPCC) to reward for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change. While environmental issues have become critical concerns all over the world, organizations are constantly under pressure to develop environmentally responsible and friendly operations. Commitment to the natural environment has become an important variable within the current competitive scenarios while companies worldwide are continuously trying to develop new and innovative ways to enhance their global competitiveness. A body of organizations enhanced their competitiveness through improvements in their environmental 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 (Bacallan, 2000; Srivastava, 2007).

As many realize that customers and other stakeholders do not always distinguish between a company and its suppliers (Bacallan, 2000), more and more companies have started to undertake significant efforts towards establishing green supply chain management (GSCM) initiatives (Srivastava, 2007; Zhu et al., 2008). The concept of GSCM encompasses environmental initiatives in inbound logistics, production, outbound logistics, and reverse logistics, including and involving materials suppliers, service contractors, vendors, distributors and end users working together to reduce or eliminate adverse environmental impacts of their activities (Beamon, 1999; Vachon and Klassen, 2006). Logistics management plays a significant role in GSCM. With the rapid development of the GSCM, the importance of environmental management for the logistics industry has increased dramatically (Skjoett-Larsen, 2000). To deliver products and services to customers more environmentally, logistics service providers need to address more efforts on environmental issues (Murphy and Poist, 2003; Sarkis et al., 2004). For example, to reduce the emission of greenhouse gas as well as to save fuel consumption, United Parcel Service (UPS), a global logistics service provider, uses a route-planning software and a internet matching system in their logistics service process. Some logistics service providers in Taiwan, such as T-Join Transportation and HCT Transportation, begin to fuel their transportation vehicles with bio-diesel. Integrating environmental management and logistics services has become an important topic for the logistic industry.

Although there is a burgeoning body of literature involving the environmental issues in a variety of business disciplines such as manufacturing and marketing, the corresponding literature involving logistics has been still small but expanding. Besides manufacturing sectors, scant attention has been paid on how these possible determinant factors influence the adoption of green practices for logistics service providers. A review of the literature indicates that research on environmental issues in logistics was virtually non-existence prior to 1990. Since the *International Journal of Physical Distribution & Logistics Management* devoted a special issue to "environmental aspects of logistics" in 1995, the topic was of sufficient importance and relevance and research on environmental issues has appeared periodically in the logistics literature. However, among others, most research on environmental issues in logistics studied reverse logistics in the supply chain system of manufacturing sectors. Only a limited number of articles focused on environmental issues in the logistics industry in the past decade. Some of these studies merely argued the importance of environmental issues for the logistics industry (Rodrigue et al., 2001; Rondinelli and Berry, 2000); some explored the environmental practices adopted by the logistics industry (Murphy and Poist, 2000, 2003; Wu and Dunn, 1995); and some also introduced some possible factors that may influence the adoption of environmental practices for the logistics companies (Murphy et al., 1994; 1995; 1996; Szymankiewicz, 1993). Only Wong and Fryxell (2004) conducted an empirical study on the influences of stakeholder pressures on the adoption of environmental management practices for the fleet companies. Much remains to be learned empirically about the adoption of environmental practices for logistics service providers.

It is not surprising that much research involving environmental issues at the industry level has focused on sectors generally acknowledged as "dirtier" or "waster," most notably the energy industry, the chemical industry, the automotive industry, the forestry/pulp/paper industry, and the electronic industry. The service sectors are traditionally assumed to have a much smaller environmental impact (Ramus and Montiel, 2005). It is likely to expect that the firms most likely to formulate environmental plans are those in the manufacturing sector which may consume more natural resources and generate more contaminants, while firms in the service sector less likely to do so (Henriques and Sadorsky, 1996; Hutchinson, 1996). However, the operation of logistics services often leads to several negative impacts on the natural environment, including air pollutants, hazardous waste disposal, solid waste disposal, fuel consumption, and others (Murphy et al., 1994; Rondinelli and Berry, 2000). The logistics industry may be "dirtier" and "waster" than other service sectors (Skjoett-Larsen, 2000; Wu and Dunn, 1995). This suggests that it is necessary to study environmental issues in the logistics industry. Although a body of research on the adoption of green practices in the manufacturing sector can provide some guidelines for the development of environmental management in the logistics industry, it is still required to conduct more research on environmental issues in the logistics industry, as firms in different industrial sectors may exhibit dissimilar attitudes toward environmental issues (Etzion, 2007; Henriques and Sadorsky, 1999; Zhu et al., 2008).

Because the development of environmental issues in the logistics industry is still in its infancy, the adoption of green practices can be taken as an innovative process for a logistics service provider. Innovation is the use of new technical and administrative knowledge to offer a new product or service to customers (Afuah, 1998). Therefore, this paper will study the topic about the adoption of green practices for logistics service providers from the perspective of innovation. The main purpose of this paper is to explore the factors that affect the willingness to adopt green innovations for logistics service providers. An understanding of the influencing factors is essential for

practitioners to best implement green practices, and for researchers to best understand what issues need to be addressed.

The next section introduces the factors influencing the adoption of green innovations. The third section gives a description of the research methodology, while the fourth section focuses on the analysis of the results and the discussion of the findings. The final section gives research conclusions.

Determinants of Adopting Green Innovation

Innovation is any practices that are new to organizations, including equipments, products, services, processes, policies and projects (Kimberly and Evanisko, 1981; Damanpour, 1991). There is a body of research studying the determinants of adopting innovations. Some researchers suggested that individual, organizational, and contextual factors would influence the adoption of technological innovation (Kimberly and Evanisko, 1981), while other researchers suggested that the adoption and implementation of technological innovation would be affected by the technological context, organizational context, and the external environmental context (Tornatzky and Fleischer, 1990). This paper will investigate the influence of technological, organizational, and environmental factors on the intention to adopt green innovations.

Technology is a kind of knowledge (Grant, 1996). An organization will have higher innovative capability when knowledge can be shared more easily within the organization (Tsai and Ghoshal, 1998). The transferability of knowledge will influence the adoption of organizational innovation. Technological innovation can be advanced when the technology has higher transferability, which is determined by the explicitness of related knowledge. It is more easily to transfer or share technological knowledge with higher explicitness (Grant, 1996; Teece, 1996). In addition to the explicitness of the technology, how the technology to be acquired fits with the knowledge or resources that a firm already possesses will also be another important factor influencing technology adoption (Tornatzky and Fleischer, 1990; Chau, & Tam, 1997). Innovation usually follows a technological paradigm (Teece, 1996). The cumulative nature of related knowledge will influence the adoption of technological innovations. An organization with rich experiences in the application or adoption of related technologies will have higher ability in technological innovation (Grant, 1996; Simonin, 1999). Therefore we would expect that explicitness and accumulation of technology might influence the adoption of green innovations.

A body of research has argued that certain features of organizations themselves, including structures, climates, and cultures of organizations, will influence the adoption of innovation (e.g. Kimberly and Evanisko, 1981; Tornatzky and Fleischer, 1990; Russell and Hoag, 2004). Management skills, organizational encouragement for innovation, and support of innovation resources are found to help the improvement of organizational innovation (Amabile, 1988). Informal linkages and communication among the employees, the quality of human resources, top management's leadership behavior and the amount of internal slack resources may significantly influence the adoption of technological innovation (Tornatzky and Fleischer, 1990). A company with higher quality of human resources such as better education or training will have higher ability in technological innovation. Therefore we would expect that organizational encouragement and quality of human resources might influence the adoption of green innovations.

The external environment in which a firm conducts its business will also influence the innovative capability as well as the intention to adopt innovations (King and Anderson, 1995). According to the research on the organizational innovation for hospitals, Kimberly and Evanisko (1981) concluded the environmental complexity and uncertainty would influence behaviors of innovation. Companies may pay more attention on innovation when they faced environments with higher instability and chaos (Miles and Snow, 1978). Environments with high uncertainties will have positive influences on the relationship between organizational structures and organizational innovation (Damanpour, 1991). Demand uncertainty tends to increase firm's incentive to adopt new technologies (Zhu and Weyant, 2003). Governmental support is another important environmental characteristic for technological innovation. Government through regulation can both encourage and discourage the adoption of innovation (Scupola, 2003; Tornatzky and Fleischer, 1990). Government can provide financial incentives, pilot projects, and tax breaks to stimulate technological innovation for logistics companies. Therefore we would expect that environmental uncertainty and governmental support might influence the adoption of green practices.

Based on above discussions, this paper suggest that the intention to adopt green innovations is positively associated with the explicitness of green practices, the accumulation of green related knowledge, the organizational encouragement, the quality of human resources, the environmental uncertainty, and the governmental support, and consequently propose the following six hypotheses:

Hypothesis H1 *The more the explicitness of the green practices, the more willingness the logistics service provider will have to adopt green innovations.*

Hypothesis H2 *The more the accumulation of the green related knowledge in the company, the*

more willingness the logistics service provider will have to adopt green innovations.

Hypothesis H3 *The more the organizational encouragement, the more willingness the logistics service provider will have to adopt green innovations.*

Hypothesis H4 *The higher the quality of human resources, the more willingness the logistics service provider will have to adopt green innovations.*

Hypothesis H5 *The more the environmental uncertainty, the more willingness the logistics service provider will have to adopt green innovations.*

Hypothesis H6 *The more the governmental support, the more willingness the logistics service provider will have to adopt green innovations.*

Research Methodology

To examine the six possible factors influencing the intention to adopt green innovations for logistics service providers, data were collected by means of mailing questionnaires to logistics companies in Taiwan. This region is interesting because, due to the trend of global environmentalism, Taiwan's government, industries, and organizations have begun to stress much emphasis on environmental issues for the sustainable development of Taiwan. For example, to screen for European RoHS compliance before Taiwan's products enter European markets, the Taiwan's government has issued numerous government programs designed to support the success of Taiwanese manufacturers overseas. Taiwan's Bureau of Standards, Metrology and Inspection (BSMI) has issued a new set of regulations that force electronic products destined for European states to undergo inspection by designated Taiwanese laboratories. These laboratories will appraise and evaluate products for their RoHS compliance through inspection and testing. Those passing inspection will be granted certificates and inspection reports bearing BSMI emblems. In addition, while small and medium-sized enterprises (SMEs) are an important driving force for economic growth but most of them can hardly adopt environmental innovations to meet the environmental compliance, the Taiwan's government, Taiwan's Small and Medium Enterprise Administration, has also launched a program to help a number of SMEs in Taiwan adopt environmental innovations to improve their environmental performance compliance to meet RoHS and WEEE requirements.

Moreover, Due to the trend of globalization, Taiwan's government has delivered several policies to make Taiwan become a global logistics center. As efficient and effective logistics is one of the key success factors that makes Taiwan become one of the important sources of electronic hardware products in the world (Shan and Marlow, 2005), it is necessary for Taiwan's logistics industry to adopt environmental innovations to help Taiwan's manufacturing companies develop their green competitiveness .Logistics is a link in providing green products and services to the consumer, and many companies have found that green products will be greener if the value adding logistics activities also become green (Wu and Dunn, 1995).

The questionnaire contains five parts: company's basic information, technological factors, organizational factors, environmental factors, and the intention to adopt green innovations. Besides the company's basic information, the other items were measured using the 5-point Likert scales anchored by 'strongly disagree' and 'strongly agree'. The green practices for the logistics industry suggested by Murphy and Poist (2000; 2003) are taken as the green innovations in this study, including hazardous and solid waste disposal, recycling materials, reducing water and air pollution, energy conservation, reducing consumption, and reusing materials. The willingness to adopt green innovations was used as measurements of green innovation adoption. Logistics service providers will try to adopt green innovations when they have strong willingness.

Explicitness of technology was measured according to the degrees that the technology can be transferred and codified (Grant, 1996; Teece, 1996; Tsai and Ghoshal, 1998). Accumulation of technology was measured according to the degrees of fitness of related technologies a firm that possessed (Chau and Tam, 1997; Grant, 1996; Simonin, 1999). Organizational encouragement was measured according to the degrees that companies' resource supports and leaders' attitudes (Amabile, 1988; Tornatzky and Fleischer, 1990). Quality of human resources was measured according to employees' environmental knowledge and innovation capabilities (Tornatzky and Fleischer, 1990). Customers' requirements, competitors' innovative abilities, and development of environmental technologies were used to measure the environmental uncertainty (Kimberly and Evanisko, 1981; Zhu and Weyant, 2003). Governmental support was measured from the perspective of finance, technology, law and human resources (Scupola, 2003; Tornatzky and Fleischer, 1990). Table 1 shows the measurement items for each factor.

Table 1
Measurement Items

Factors	Measuring Items
Explicitness of technology	(1) It is easy to find books or other resources about the practice. (2) It is easy to learn the application of the practice from the books. (3) It does not need too many experiences to learn the practice. (4) It is easy to understand that green practice.
Accumulation of technology	(1) It is necessary to have experiences of using related practices. (2) Our company has implemented many related green knowledge. (3) It is easy to integrate that practice with company's current system.
Organizational encouragement	(1) Company's leaders encourage employees to learn green information. (2) Our Company provides rewards for green employees. (3) Our company provides supports for employees to learn green information. (4) Company's leaders can help employees when they face green problems.
Quality of human resources	(1) Employees can learn new technologies easily. (2) Employees usually provide new ideas for companies. (3) Employees possess abilities to use new technologies to solve problems. (4) Employees can share knowledge with each others.
Environmental uncertainty	(1) The advance in new logistics service modes is quickly. (2) Competitors usually provide new logistics services. (3) Customers' requirements are diversified. (4) Customers' requirements vary quickly.
Governmental support	(1) Government provides financial support for developing green practices. (2) Government encourages companies to propose green logistics projects. (3) Government helps training manpower with green logistics skills. (4) Government sets the environmental regulations for the logistics industry.
Green Innovations	(1) Hazardous and solid waste disposal, (2) Recycling materials, (3) Reducing water and air pollution, (4) energy conservation, (5) reducing consumption, (6) reusing materials

Logistics service providers carry out logistics activities for their customers, which include warehousing, transportation, inventory management, order processing, and packaging (Delfmann et al., 2002; Sink et al., 1996). The sample frame was drawn from members of the Logistics Council in Taiwan. Via the Internet, we also collected several companies, whose business models conforming to the logistics services. Five hundred questionnaires were mailed to the sampled companies in 2007. In total, 164 completed questionnaires were returned. Of these respondents, 11 unconfident questionnaires were excluded. The overall response rate is 30.6 percent. Table 2 shows some basic information of the sample. It can be found that most logistics service providers in Taiwan belong to small and medium size enterprises. According to the reliability coefficients in Table 3, the smallest value of Cronbach's alpha for this study is 0.8066. This implies that the sampling results are reliable (Nunnally, 1978).

Table 2
Basic Information of the Sample

	Category	Number	Percentage (%)
Company history (Years)	0~5	39	25.4
	6~10	40	26.1
	11~20	46	30.1
	Above 20	28	18.4
Number of employee	Below 50	38	24.8
	51~100	34	22.2
	101~300	31	20.3
	301~500	28	18.3
	Above 501	22	14.4
Capital (Million, NT Dollars)	Below 5	39	25.5
	5~10	33	21.6
	10~50	34	22.2
	50~500	27	17.6
	Above 500	20	13.1

Table 3
Results of Reliability Analysis

Factors	Cronbach's alpha
Explicitness of technology	α = 0.8231
Accumulation of technology	α = 0.8179
Organizational encouragement	α = 0.9021
Quality of human resources	α = 0.8793
Environmental uncertainty	α = 0.8066
Governmental support	α = 0.8994
Overall	α = 0.8601

Research Findings and Discussions

To find the influences of explicitness of technology, accumulation of technology, organizational encouragement, quality of human resources, environmental uncertainty and governmental support on the intention to adopt green innovations, the method of regression analysis was used. This paper took these six factors as independent variables and the willingness to adopt green practices as the dependent variable in the regression model. Moreover, as firm size and history (Spencer, 2003) might influence the adoption of technological innovation, company history, number of employee, and capital size are taken as the control variables in the regression analysis. Table 4 shows the results of regression analysis. In the present regression model, the regression assumptions of homoescedasticity, linearity, normality, independence of residuals, and the absence of multicollinearity are all satisfied.

Table 4
Regression Results for the Determinants of Adopting Green Innovations

Dependent variable: Willingness to adopt green innovations		
Independent/Control variables	Standardized Coefficient β	*t*
Explicitness of technology	0.111	2.834**
Accumulation of technology	0.134	3.961**
Organizational encouragement	0.199	4.996**
Quality of human resources	0.177	4.986**
Environmental uncertainty	0.129	3.010**
Governmental support	0.209	5.158**
Company history	0.036	0.873
Number of employee	0.021	0.972
Capital size	0.087	1.976*
R^2	0.701	
adj R^2	0.682	
F	11.429**	

* $p<0.05$ ** $p<0.01$

Technological, organizational and environmental factors have positive influences on the intention to adopt green practices. Explicitness and accumulation of green technology, organizational encouragement, quality of human resources, environmental uncertainty, and governmental support all exhibit significant influences on the willingness to adopt green practices. This means that all the proposed hypotheses are supported. Higher explicitness of green practices can help the transfer of technological knowledge within the logistics company and, therefore, raise logistics service providers' intention to adopt green innovations. More accumulation of environmental-related knowledge can make logistics companies have more related knowledge to adopt green practices. Organizational encouragement, especially top management support, can give employees motivation to adopt environmental practices. Murphy et al. (1996) have addressed that lack of top management support is a major obstacle to establishing environmental policies. High quality of human resources means that employees are capable of adopting and implementing green practices. Embracing the notion of adopting green practices requires a fundamental shift in a firms' culture and human resources and the organizational capabilities required to management them. Management, R&D, production, and marketing all must be involved and committed if a firm is to implement a policy of using clean technologies (Ashford, 1993; Hart, 1995). Use of green practices may add complexity to production or delivery processes and requires increased skills from workers at all levels of the firm (Groenewegen and Vergrat, 1991). The process of adopting green practices thus builds within a firm the resources of organizational commitment and learning, cross-functional integration, and increased employee skills and participation, which are emerging as prime resources in the modern competitive environment (Russo and Fouts, 1997). Governmental support can encourage and guide logistics service providers to adopt green innovations. The government should seriously consider funding initiatives to help businesses that are leading the way in green product development and perhaps apply tariffs to less efficient products on the market. Rodrigue et al. (2001) have also suggested that government intervention promoting greater environmental regulation is important in developing logistics.

Conclusions

It is generally perceived that green innovations help to enhance environmental performance, minimize waste and achieve cost savings, and consequently promote efficiency and synergy among business partners and their lead corporations. There are many businesses that have undertaken significant efforts towards adopting green innovations. The motivation and driving forces for adopting green innovations have been examined in some research;

however, most of them focused on manufacturing sectors. There are some explanations as to why manufacturing firms should engage in environmental activities. Yet, all organizations are not exposed to the same types of pressure or to the same extent. Thus, there is a clear research need to determine the potential factors that will influence the willingness to adopt green innovations for service sectors. This paper gives some explanations, from the perspective of innovation, as to what factors influencing the intention to adopt green innovations for logistics service providers.

According to the present results, the factors affecting the adoption of green innovations are divided into technological, organizational, and environmental factors. These factors have positive influences on the willingness to adopt green practices. Explicitness and accumulation of environmental practices, organizational encouragement, quality of human resources, environmental uncertainty and governmental support exhibit significant influences on the willingness to adopt green innovations for logistics service providers. Based on the research results, it is found that higher explicitness of green practices can help the transfer of technological knowledge within the organization and, consequently, can raise the willingness to adopt green practices. Logistics companies can also increase their progress in green innovations by encouraging or supporting their employees to environmental activities and by training and educating their employees to become environment-friendly workers. The government should provide financial incentives, pilot projects, and tax breaks to stimulate the adoption of green practices for logistics industry. This paper only studies the factors influencing the adoption of green innovations for logistics service providers in Taiwan. A study on the relationships among the adoption of green innovations, environmental performance and supply chain performance can also be conducted in the future. Moreover, other possible influential factors on the adoption of green innovations can also be taken into considerations in a further study.

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