Adoption of Green Supply Chain Practices in Taiwan's Logistics Industry

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ABSTRACT

Factors influencing the adoption of green supply chain practices for the logistics industry in Taiwan from the perspective of technology, organization and environment are studied. The data came from a 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 adoption of green supply chain practices. Moreover, explicitness and accumulation of technology, organizational encouragement, quality of human resources, and governmental support exhibit significant influences on the willingness to adopt green supply chain practices.

***Keywords**: Green Supply Chain, Logistics Industry, Technological Innovation*

INTRODUCTION

With the rapid growth of technologies, an amount of research has shown that the adoption of technological innovations is the most important tool for businesses to keep their competitive advantage. Businesses worldwide are continuously trying to develop new and innovative ways to enhance their global competitiveness. More and more businesses begin to enhance 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). Green supply chain management (GSCM) is an environmental concept that is gaining popularity in the world. For many businesses in the world, adopting GSCM is a way to demonstrate their sincere commitment to sustainability. GSCM as a form of environmental improvement is an operational initiative that many businesses are adopting to address such environmental issues (Rao & Holt, 2005). GSCM is one of the more popular emerging corporate environmental management topics that have arisen over the past decade. There are a number of researchers studying GSCM. The growth in this literature can extend back to the early 1990's with the advent of environmentally conscious manufacturing strategy, corporate environmental management, and supply chain management literature. A range of aspects on GSCM studies have been covered, including drivers and/or pressures for GSCM. The literature has ranged from empirical studies to modeling the behavior of GSCM including such topics as green purchasing, eco-design, remanufacturing, disassembly, product stewardship, and reverse logistics.

It is generally perceived that green supply chain practices (GSCP) help to enhance environmental performance, minimize waste and achieve cost savings, and consequently promotes efficiency and synergy among business partners and their lead corporations, and. This synergy is expected to enhance the corporate image, marketing exposure, and competitive advantage. Businesses will adopt GSCP if they identify that this will result in specific financial and operational benefits (Bowen, Cousins, Lamming, &

Faruk, 2001). There are many businesses that have undertaken significant efforts towards adopting GSCP. The motivation and driving forces for adopting GSCP have been examined in some research (Bacallan, 2000; Rao, 2004); however, most of them focused on manufacturing sectors. There are some explanations as to why manufacturing firms should engage in GSCM activities. Yet, all organizations are not exposed to the same types of pressure or to the same extent (Christmann & Taylor, 2001). For example, with Kyoto Protocol requirements and international pressures for reducing greenhouse gas emissions, there may be differing and increased pressures on those industries that are heavy emitters of greenhouse gases. Some industries are more domestic in orientation (e.g. power generation industry) while other industries are more globally focused (e.g. electronic industry) and thus will have differing national and international pressures and motivations for adopting GSCP. Different industries have different situations in competition and environmental uncertainty, and as a result, businesses in different sectors face different types and intensities of environmental challenges. Thus, there is a clear research need to determine the potential factors that will influence the willingness to adopt GSCP for service sectors.

Supply chain management has received tremendous attention both from the business world and from academic researchers during the last decade. Supply chain management can be defined as "a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements" (Simchi-Levi, Kaminsky, & Simchi-Levi, 2003). Supply chain management include all the activities associated with the flow and transformation of materials from raw extraction phase through to the consumption of goods and services by an end user, along with associated information flows, both up and down the supply chain (Handfield, & Nichols, 1999). 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 (Rao & Holt, 2005). Many researchers have explored environmental initiatives within each of the major phases of the supply chain (Sarkis, 1999). Due to the emergence of the concept of supply chain management, logistics management has become a strategic factor that provides a unique competitive advantage in the global market (Christopher, 1993). One of the keys to effective supply chain management is to make the logistics function more efficiently in the supply chain. Consequently, logistics companies play an important role in the supply chain (Bowersox, Closs, & Cooper, 2002). The purpose of logistics is the supply of service or product to the demander or demanding unit at the right time, with the right quantity, in the right quality, with the right cost and at the right place. Over the past decade, many logistics companies have acknowledged the importance of environmental issues in their supply chains. Therefore, this paper will study the topic about the adoption of GSCP for logistics companies. The main purpose of this paper is to explore the factors that affect the willingness to adopt GSCP for logistics companies from the perspective of technology, organization and environment. An understanding of the influencing factors is essential in order for practitioners to best implement GSCP, and for researchers to best understand what issues need to be addressed.

The next section introduces the theoretical foundations of the determinants of adopting GSCP. 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 GSCP

Because the application of GSCP in logistics industry is still in its infancy, the adoption of GSCP can be taken as an innovative process for a logistics company. Therefore, this paper will utilize the concept of innovation to investigate the factors affecting the willingness to adopt GSCP. Innovation is the use of new technical and administrative knowledge to offer a new product or service to customers (Afuah, 1998). Innovation is any practices that are new to organizations, including equipments, products, services, processes, policies and projects (Kimberly, & Evanisko, 1981; Damanpour, 1991).

There is a body of research studying the determinants of adopting innovations (Kimberly, & Evanisko, 1981; Amabile, 1988; Tornatzky, & Fleischer, 1990; Damanpour, 1991; Wolfe, 1994; Tidd, Bessant & Pavitt, 1997). Some researchers suggested that individual, organizational, and contextual factors would influence the adoption of technological innovation (Kimberly, & 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, & Fleischer, 1990). This paper will investigate the influence of technological, organizational, and environmental characteristics on the adoption of GSCP.

Technological Factors

Technologies can be viewed as one kind of knowledge (Grant, 1996). An organization will have higher innovative capability when knowledge can be shared more easily within the organization (Tsai, & Ghoshal, 1998). The transferability of knowledge or technology will influence technological innovation; technological innovation can be advanced when the technology has higher transferability. The transferability of technology is determined by the explicitness of technology. 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 fits with the technologies that a firm already possesses will also be another important technological characteristic (Tornatzky, & Fleischer, 1990; Chau, & Tam, 1997). Technological innovation usually follows a technological paradigm (Teece, 1996). The cumulative nature of technologies will influence the innovation in technologies. 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 GSCP. The following hypotheses are consequently proposed:

Hypothesis H1a. *The more the explicitness of the GSCP technology, the logistics company will have more willingness to adopt GSCP.*

Hypothesis H1b. *The more the accumulation of the GSCP related technology in the company, the logistics company will have more willingness to adopt GSCP.*

Organizational Factors

A body of research about organizational behaviors has argued that certain features of organizations themselves, including structures, climates, and cultures of organizations, will influence the adoption of innovation (Kimberly, & Evanisko, 1981; Tornatzky, & Fleischer, 1990, Russell, & 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 will significantly influence the adoption of technological innovation (Tornatzky, & Fleischer, 1990). A firm 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 GSCP. The following hypotheses are proposed:

Hypothesis H2a. *The more the organizational encouragement, the logistics company will have more willingness to adopt GSCP.*

Hypothesis H2b. *The higher the quality of human resources, the logistics company will have more willingness to adopt GSCP.*

Environmental Factors

In addition to technological and organizational characteristics, the external environment in which a firm conducts its business will also influence the innovative capability (King, & Anderson, 1995). Organization will pay more attention on innovation when they faced environments with higher instability and chaos (Miles, & Snow, 1978). Kimberly and Evanisko (1981) concluded the environmental complexity and uncertainty would influence the organizational innovation for hospitals. 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. Governmental support is another important environmental characteristic for technological innovation (Zhu, & Weyant, 2003). Government through regulation can both encourage and discourage the adoption of innovation (Tornatzky, & Fleischer, 1990; Scupola, 2003). Government can provide financial incentives, pilot projects, and tax breaks to stimulate technological innovation for logistics service providers. Therefore we would expect that environmental uncertainty and governmental support might influence the adoption of GSCP. The following hypotheses are proposed:

Hypothesis H3a. *The more the environmental uncertainty, the logistics company will have more willingness to adopt GSCP.*

Hypothesis H3b. *The more the governmental support, the logistics company will have more willingness to adopt GSCP.*

METHODOLOGY

To examine the possible factors influencing the adoption of GSCP for the logistics industry, data were collected by means of mailing questionnaires to logistics companies in Taiwan. This region is interesting because Taiwan is one of the important sources of electronic hardware products in the world, and its effective logistics operations is one of the key success factors of Taiwan (Shan, & Marlow, 2005). Moreover, due to the trend of globalization, Taiwan's government delivered several policies to make Taiwan become a global logistics center. Many LSPs in Taiwan begin to adopt new technologies because of global logistics policies. 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 2006. In total, 173 completed questionnaires were returned. Of these respondents, 11 incomplete or unconfident questionnaires were excluded. The overall response rate is 32.2 percent.

The questionnaire contains five parts: company's basic information, technological factors, organizational factors, environmental factors, and the adoption of GSCP. There are 48 items in the

questionnaire. Besides the company's basic information, the other items were measure using the 5-point Likert scales anchored by 'strongly disagree' and 'strongly agree'. The willingness to adopt GSCP is measured. Explicitness of technology was measured according to the degrees that the technology can be transferred and codified (Grant, 1996; Teece, 1996; Tsai, & Ghoshal, 1998). Accumulation of technology was measured according to the degrees of fitness of related technologies a firm that possessed (Grant, 1996; Chau, & Tam, 1997; Simonin, 1999). Organizational encouragement was measured according to the degrees that companies' resource supports and leaders' attitudes (Amabile, 1988; Tornatzky, & Fleischer, 1990). Quality of human resources was measured according to employees' information skills and innovation capabilities (Tornatzky, & Fleischer, 1990). Customers' requirements, competitors' innovative abilities, and development of logistics technologies were used to measure the environmental uncertainty (Kimberly, & Evanisko, 1981; Zhu, & Weyant, 2003). Governmental support was measured from the perspective of finance, technology, law and human resources (Tornatzky, & Fleischer, 1990; Scupola, 2003).

The measured scales were submitted to factor analysis. Factors with eigenvalues greater than 1.0 for each characteristic are summarized in Table 1. The technological factors include explicitness of technology and accumulation of technology, the organizational factors include organizational encouragement and quality of human resources, and the environmental factors include environmental uncertainty and governmental support. The result of factor analysis confirms the construct validity of this study. According to the reliability coefficients, the smallest value of Cronbach's alpha for this study is 0.7198. This implies that the sampling results are reliable (Nunnally, 1978).

Table 1 Factor and Reliability Analysis

Factors	Cronbach's alpha
Technological factors	
Explicitness of technology	$\alpha = 0.8011$
Accumulation of technology	$\alpha = 0.8347$
Organizational factors	
Organizational encouragement	$\alpha = 0.8974$
Quality of human resources	$\alpha = 0.7198$
Environmental factors	
Environmental uncertainty	$\alpha = 0.8577$
Governmental support	$\alpha = 0.8014$
Overall	$\alpha = 0.8601$

RESULTS AND DISCUSSIONS

To find the influence of technological, organizational, and environmental factors on the adoption of GSCP, the method of regression analysis was used in this study. Based on the above results obtained by the method of factor analysis, the technological characteristics can be classified into explicitness of technology and accumulation of technology; the organizational characteristics can be classified into organizational encouragement and quality of human resources; the environmental factor can be classified into environmental uncertainty and governmental support. This paper took these six factors as independent variables and the willingness to adopt GSCP as the dependent variable, and consequently, employed the method of regression analysis to determine their relationship, as shown in Table2.

Table 2 shows the results of regression analysis. It can be found that the technological, organizational and environmental factors have positive influences on the adoption of GSCP. Explicitness and

accumulation of GSCP technology, organizational encouragement, quality of human resources, and governmental support exhibit significant influences on the willingness to adopt GSCP. This means that the hypotheses, H_{1a}, H_{1b}, H_{2a}, H_{2b}, and H_{3b} are supported, but the hypothesis H_{3a} is not supported. It can be concluded that higher explicitness of technology can help the transfer of technological knowledge within the organization and, therefore, raise the willingness to adopt GSCP. More accumulation of GSCP related technologies can make logistics companies have more related knowledge to adopt GSCP technology. Organizational encouragement can give employees motivation and support to adopt environmental practices. High quality of human resources means that employees are capable of adopting and implementing GSCP. Embracing the notion of adopting GSCP 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 GSCP adds complexity to production or delivery processes and requires increased skills from workers at all levels of the firm (Groenewegen & Vergrat, 1991). The process of adopting GSCP 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 & Fouts, 1997). Governmental support can encourage and guide logistics service providers to adopt GSCP. 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.

Table 2 Regression Results for the Determinants of Adopting GSCP

Dependent variables: Willingness to adopt GSCP			
Independent variable		Coefficient β	*t*
Constant		0.131	1.104
Technological	Explicitness	0.301	3.844**
	Accumulation	0.274	1.961*
Organizational	Encouragement	0.328	4.496**
	Human Resource	0.341	4.816**
Environmental	Uncertainty	0.118	1.109
	Government	0.297	4.527**
R^2		0.471	
adj R^2		0.442	
F		7.726**	

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

CONCLUSIONS

The importance of studying GSCM has increased in recent years. End-of-life take-back laws have proliferated over the past decade both in the world, requiring businesses to effectively manage the entire life of the product (Fishbein, 1994; Toffel, 2003). The global supply chain have faced more challenges, including Kyoto Protocol, WEEE, REACH, EU RoHS and state laws here in the United States. To respond to international commitment, such as the over reduction of greenhouse gas emissions, several reports concerning reduction and reuse of fluorinated compounds have been reviewed. Consumers also have continuingly pressured businesses to take responsibility for the disposal of their products that

contain hazardous waste. Landfill capacity has become limited and expensive. Alternatives such as repackaging, remanufacturing and recycling have become more prevalent and viable (Thierry, Salomon, van Nunen, & van Wassenhove, 1995; Thorn & Rogerson, 2002). There are some explanations as to why firms should engage in GSCM activities.

According to the present results, it can be found that the factors affecting the adoption of GSCP are divided into technological, organizational, and environmental factors. These factors have positive influences on the willingness to adopt GSCP. Moreover, explicitness and accumulation of GSCP technology, organizational encouragement, quality of human resources, and governmental support exhibit significant influences on the willingness to adopt GSCP for logistics companies. Based on the research results, it is found that higher explicitness of GSCP technology can help the transfer of technological knowledge within the organization and, consequently, can raise the willingness to adopt GSCP. Logistics companies can also increase their adoption of GSCP 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 GSCP for logistics industry. This paper only studies the factors influencing the adoption of GSCP for logistics companies in Taiwan. A study on the relationship between the adoption of GSCP and global supply chain performance can also be conducted in the future. Moreover, other possible influential factors on the adoption of GSCP can also be taken into considerations in a further study.

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