An Empirical Study on Organizational Infusion of Green Practices in Chinese Logistics Companies

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Abstract: *As environmental considerations have become a fundamental part of business strategies, there is a challenge for managers and academicians to explore the integration of environmental concepts and business operations. Although a number of studies on green practice adoption can be found in the literature, few of them analyzed the infusion of green practices in organizations. Furthermore, most prior research of green management focused on manufacturing sectors; scarce attention was paid on research in service sectors. This paper focuses on the green practice infusion in logistics companies because many logistics operations often lead to several environmental impacts. The main purpose of this paper is to explore the factors that affect organizational infusion of green practices in Chinese logistics companies. Drawing on the innovation diffusion theory, this paper groups the determinant factors into technological, organizational and environmental dimensions. We explored the influences of determinant factors on green practice infusion by conducting a questionnaire survey on logistics companies in China. The regression analysis is used to test proposed research hypotheses in the study Research findings reveal that complexity, compatibility and relative advantage of green practices, quality of human resources, organizational support, governmental support and regulatory pressure exhibit significantly influences on green practice infusion for the logistics companies in China. The influences of adoption cost, company size, environmental uncertainty and customer pressure on logistics companies' green behavior are not significant. This paper can extend the scope of research on green management in service industries and green practice infusion.*

Keywords: *Green practice infusion, Logistics companies, Determinant factors, China*

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Introduction

To pursue sustainable development, many companies are attentive to enhancing their competitiveness through improvements in the environmental performance and mitigating the environmental impact of their production and service activities. As implementing green practices can be regarded as an important means of solving firms' environmental problems, it is particularly important to learn more about the factors influencing green practice implementation. Green management also becomes critical concerns of business research. Many researchers have surveyed firms' implementation of environmental management practices, and proposed various explanations as to what factors influence firms' adoption of green practices. However, scarce attention has been paid on analyzing the infusion behaviors associated with green practices.

Companies may be able to achieve considerable environmental performance by successfully implementation green practices into their work systems. Green practice implementation is a multiphase process consisting of adoption and infusion phases (Winn and Angell, 2000). Infusion refers to the extent to which an innovation's features are in widespread usage in a complete and sophisticated way (Fichmen 2001; Yan and Fiorito, 2007). Green practice infusion is the incorporation of green practices into work structures. Successful implementation of green practices requires significant involvement in developing operational responses to environmental issues. It is important to understand the infusion of green practices within organizations. Some researchers have analyzed the infusion of green practices within organizations, concerning with the extent to which these practices have been implemented (Fussel and Georg, 2000; Stead et al., 1998; Winn and Angell, 2000). However, these studies focused on exploring the infusion process of green practices within an organization. Much remains to be learned empirically about the factors influencing organizational infusion of green practices.

To fill the research gap, this paper studies the infusion of green practices in Chinese logistics service providers. This study focuses on the logistics industry because many logistics operations often lead to several negative environmental impacts. Although there is a burgeoning body of literature concerning with environmental issues in a variety of business disciplines such as manufacturing and marketing, the corresponding literature involving logistics has been still small but expanding (Gunasekaran and Cheng, 2008; Murphy and Poist, 2000). Furthermore, while China continues to develop into a global manufacturing base and a huge consumer

market, it suffers from various serious environmental problems such as air pollution, energy waste, and water pollution. Several researchers have investigated the implementation of environmental management in Chinese manufacturing companies. Scant attention has been paid to the environmental issues in Chinese service sectors.

The main purpose of this paper is to study the factors that affect organizational infusion of green practices in Chinese logistics service providers. An understanding of the determinant factors of green practice infusion is essential for researchers to best understand the issues that need to be addressed as well as for practitioners to best implement green practices. Due to the lack of research on determinants of organizational infusion of green practices, this paper can broaden the scope of research on environmental management by providing some explanations as to what factors influencing green practice infusion. Furthermore, as the implementation of green practices not only relates to the logistics industry, but also needs the attention of the government, manufacturers and consumers, verifying possible factors influencing the organizational infusion of green practices can give the government some valuable suggestions in designing environmental policies for the logistics industry, and help manufacturers, consumers, and logistics service providers themselves appreciate the drivers and barriers to implementing green management practices.

Literature Review

Organizational infusion of green practices

To achieve environmental performance, many companies attempt to implement several green practices. Applying environmental criteria into corporate operations requires exploring new resource combinations and deploying existing resources in new ways (Hart, 1995). Green practice implementation involves using new or modified processes and techniques to reduce environmental harms. As innovation is the use of new technical and administrative knowledge (Kimberly and Evanisko, 1981; Damanpour, 1991), the implementation of green practices can be regarded as an innovation process. Several researchers (e.g., Hansen et al., 2002; Henriques and Sadorsky, 2007; Lin and Ho, 2011; Rothenberg and Zyglidopoulos, 2007; Ziegler, and Seijas Nogareda, 2009) have analyzed environmental issues from the perspective of innovation.

From the innovation diffusion perspective, implementing innovations is a multiphase process and has been divided into a variety of phases (Damanpour and Schneider, 2006; Rogers, 2003). Innovation diffusion is a stage-based process of spreading a new technology within a universe of potential adopters. The adoption of an innovation does not guarantee that there is a widespread usage of the innovation within the organization to fulfill the full potentials of the innovation. A new technology may be introduced with a great enthusiasm and widespread initial acquisition; nevertheless it may fail to be thoroughly deployed among many firms (Fichman and Kemerer 1999).

Cooper and Zmud (1990) suggest a six-stage model of innovation diffusion, consisting of (1) initiation: scanning organizational problems, collecting and evaluating the information for innovation solutions, and finding the "right" innovation application for the organization, (2) adoption: getting organizational support and resource commitment for innovation implementation by negotiation, (3) adaptation: installing the innovation application, adjusting both the innovation and organizational procedures to achieve a good fit, and preparing employees to use the innovation, (4) acceptance: encouraging employees to commit to using the innovation application in their work, (5) routinization: using the innovation application to become a part of the working procedures and employees' habit, and (6) infusion: using the innovation application in a more integrated manner to obtain its full potential in supporting the organization's work. Rogers (2003) summarizes that the adoption process of innovations can be grouped into three more general phases of pre-adoption, adoption decision, and post-adoption. Zhu, Kraemer and Xu (2006) simplified above six stages into three stages of initiation, adoption, and infusion. Damanpour and Schneider (2006) suggest a three-stage model of diffusion process consisting of initiation, adoption decision, and infusion.

Like the implementation of other kinds of innovation, green practice implementation is also a process consisting of multiple stages, i.e. initiation activities, the managerial decision to adopt the green practices, and infusion activities. Companies may be able to achieve considerable environmental performance by successfully diffusing green practices into their work systems in all diffusion stages (Fussel and Georg, 2000). Winn and Angell (2000) address that corporate greening starts with top management awareness of the need for corporate responses to environmental issues, leads to policy commitment, and ideally, ends with implementation at the operational level. The infusion stage is the conclusion of technology implementation and is a post-adoption behavior. It means that

technology has been embedded and routinized in organization (Chang and Lung, 2002). Green practice infusion is the incorporation of green practices into work structures.

Infusion refers to the extent to which an innovation's features are in widespread usage in a complete and sophisticated way (Fichmen 2001; Yan and Fiorito, 2007). The extent to which innovation infusion is reached is positively related to the performance of the work that the innovation supports (Yu et al., 2009; Taylor and McAdam, 2004). Successful implementation of green practices requires significant involvement in developing operational responses to environmental issues (Stead et al., 1998). It is important and necessary to understand the infusion of green practices within organizations.

Prior literature has focused more on the issues of green management adoption decision For example, Del Brio and Junquera (2003) summarized some factors influencing green innovation in small and medium-sized enterprises, including financial resources, management style, human resources, manufacturing activity, technological approach, innovative capacity, and external cooperation. Rothenberg and Zyglidopoulos (2007), in a study of the printing industry, found that the adoption of green innovations was positively associated with the dynamism of the company's task environment. Henriques and Sadorsky (2007) found that total quality management and external stakeholder pressure would increase the likelihood that Canadian manufacturing companies implement cleaner technical innovations. Liu et al. (2010) argue that Chinese firms' adoption of green practices is influenced by the coercive pressure from the organizations holding mandatory power, normative pressure from the industrial association and the public, and mimetic pressure from the competitors. Stakeholder pressure, environmental regulation, company size, managers' characteristics, human resources and industry sector are relevant variables frequently appeared in studies on green practice adoption decision (Etzion, 2007; Gonzalez-Benito and Gonzalez-Benito, 2006).

Little attention has been paid on analyzing the infusion behavior associated with green practices. Some researchers have analyzed the infusion of green practices within organizations, concerning with the extent to which these practices have diffused (Fussel and Georg, 2000; Stead et al., 1998; Winn and Angell, 2000). However, these studies focused on exploring the infusion process of green practices within an organization. Fussel and Georg (2000) explore how an environmental management tool becomes embedded in a Danish public university hospital,

including how a green idea travels from one setting to another and becomes an object, how the green idea is translated and mobilized into action by the hospital managers and made to perform in different contexts, and how hospital managers develop a new sense of identity. Stead et al. (1998) suggest that infusion (institutionalization) is a pivotal organizational process which determines whether a firm's environmental performance results in improved operating efficiency and market opportunities or in increased legal and regulatory hassles. In a study of the implementation of the 1991 German Packaging Ordinance, Winn and Angell (2000) propose an internal process model of corporate greening that integrates policy commitment and implementation dimensions. Corporate greening process starts with awareness of the need for corporate responses to environmental issues, leads to policy commitment and, ideally, ends with infusion (implementation) at the operational level.

Although Christmann and Taylor (2006) and Darnall (2006) have analyzed the factors influencing a firm's decision to totally or partially mandate its operational units to certify to ISO 14001, they did not explore the degree of infusion of environmental management practices within the organizations. In a study of Chinese companies, Christmann and Taylor (2006) conclude that ISO-certified companies in China select their level of compliance depending on customer preferences, customer monitoring, and expected sanctions by customers. Drawing on institutional theory and the resource-based view of the firm, Darnall (2006) analyzes the influences of regulatory pressures, market pressures, complementary resources, experiences with quality management systems, and experiences with pollution prevention on U.S. firm's decision in mandating ISO 14001 totally or partially. These two studies focused on the adoption decision regarding to whether a firm implements ISO 14001 substantively. A review on current research on environmental management reveals that, up to date, there is no literature give an analysis on the factors influencing infusion of green management practices in organizations.

Factors influencing organizational infusion of green practices

To fill the research gap, this paper attempts to study the factors affecting the infusion of green practices in Chinese logistics service providers. Although a body of research has proposed several factors influencing green practice adoption, factors affecting adoption decision may actually have the opposite effects upon infusion behavior (Cooper and Zmud, 1990; Damanpour and Schneider, 2006; Tornatzky and

Fleischer, 1990; Zhu et al., 2006). For example, in a study of the diffusion of Internet-based e-business innovations, Zhu et al. (2006b) address that firm size are positively related to e-business adoption, but negatively related to infusion. The costs in implementing innovations have been a barrier for the adoption of innovations, but the higher adoption costs could motivated the infusion of innovations in organizations (Cooper and Zmud, 1990). In general, the infusion of green practices could be influenced by a variety of factors. Because implementing green practices can be seen as an innovation process, studies on explanations as to what factors influence innovation infusion will be helpful for modeling green practice infusion in this paper.

Several studies have proposed a variety of factors influencing innovation infusion. Meyer and Goes (1988) address that organizational assimilation of innovations in hospitals is influenced by environmental, organizational, and innovation variables. According to meta-analysis results, Damanpour (1991) conclude that organizational innovation is significantly associated with a firm's specialization, functional differentiation, professionalism, centralization, managerial attitude toward change, technical knowledge resources, administrative intensity, slack resources, and external and internal communication. Fichman and Kemerer (1997) explore the influence of organizational learning capability on the infusion of software process innovations. Eder and Igbaria (2000) explore the influences of earliness of adoption, top management support, organizational structure, organizational size, information technology (IT) infrastructure, and IT structure on organizational infusion of intranets. Frambach and Schillewaert (2002) suggest that the determinants influencing organizational implementation of innovations include perceived innovation characteristics, adopter's organizational characteristics, and environmental influences. The availability and quality of internal resources and external knowledge, the knowledge transfer activities, and the political and legal environment are relevant for the adoption of technical innovations.

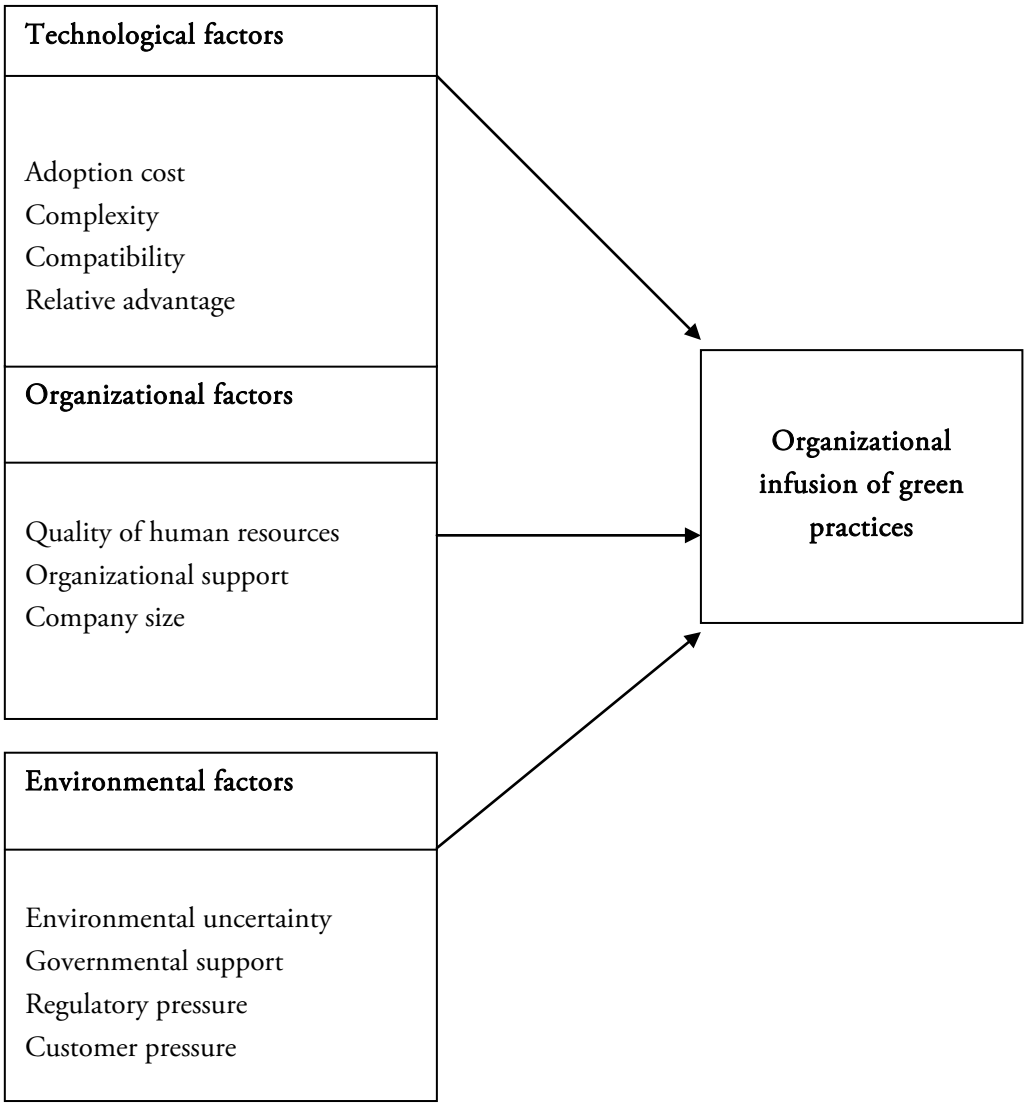
Ranganathan et al. (2004) argue that managerial IT knowledge, unit structure, supplier interdependence, competitive intensity, and IT activity intensity would affect internal infusion of Web technologies in supply chain management. In a study of public organizations in the U.S., Damanpour and Schneider (2006) analyze the influences of environmental, organizational and top managers' characteristics on the adoption and infusion of innovations in organizations. Zhu et al. (2006) suggest that technology readiness, technology integration, firm size, global scope, managerial obstacles, competition intensity and regulatory environment would influence e-

business infusion. Yan and Fiorito (2007) analyze the influences of external pressures, internal pressures, and firm size on the infusion of computer aided design/computer aided manufacturing in the U.S. textile and apparel industries. Yu et al. (2009) address that procurement process readiness, business knowledge of IT managers, organizational integration, organizational slack resources would influence the infusion of e-procurement applications.

While a variety of determinants of innovation infusion have been proposed in the previous studies, these factors can be grouped into technological, organizational and environmental context. According to the innovation diffusion theory (Rogers, 2003; Tornatzkey and Fleischer 1990), a model for any innovation diffusion needs to consider different factors that can influence the inclination to use the innovation in its specific technological, organizational, and environmental contexts of an organization. The technological, organizational, and environmental (TOE) framework (Tornatzkey and Fleischer, 1990) is widely used in studying innovation adoption and infusion from contextual perspectives. Lin and Ho (2011) have also utilized the TOE framework in analyzing green practice adoption decision for Chinese logistics companies; however, their study did not investigate the infusion of green practices in the firms.

The TOE framework identifies three aspects of a firm's context that have influences on innovation infusion. Technological dimension includes technology issues associated with the firms. Organizational dimension refers to descriptive measures such as company size, the quality of human resources, top management strategic behavior, and the availability of slack resources. Environmental dimension is the arena in which a firm conducts its business, including competitors, access to resources, industrial environment, and government regulations (Tornatzky and Fleischer, 1990). Therefore, based on the TOE framework (Lin and Ho, 2011), this paper attempts to study the influences of technological, organizational, and environmental factors on the infusion of green practices in Chinese logistics service providers. Figure 1 illustrates the research framework of the study. The technological factors include the adoption cost, complexity, compatibility and relative advantage of green practices; the organizational factors include quality of human resources, organizational support, and company size; and environmental factors include environmental uncertainty, governmental support, regulatory pressure, and customer pressure.

Figure 1. Research framework



Technological factors

Characteristics of an innovation such as compatibility, complexity, and relative advantage may affect innovation diffusion (Jeyaraj et al., 2006; Rogers, 2003; Tornatzky and Klein, 1982). Frambach and Schillewaert (2002) place the perceived characteristics of the innovation at the heart of their organizational innovation diffusion model. Boiral (2002) argues that characteristics of environmental knowledge are relevant in environmental management. Therefore, technological characteristics should be taken into account when analyzing the infusion of green practices. The perceived technological characteristics of an innovation can be considered as cognitive beliefs reflected in an attitude towards the innovation. Several technological characteristics of an innovation can affect its diffusion, including complexity, compatibility, relative advantage, triability, observability, ease of use, perceived usefulness, information intensity, uncertainty, and so on (Frambach and Schillewaert, 2002; Jeyaraj et al., 2006; Taylor and McAdam, 2004; Tornatzky and Klein, 1982; Zhu et al., 2006). The present study only considers adoption costs, complexity, compatibility and relative advantage because these characteristics have consistently been found to be more important in influencing innovation adoption behavior than the other characteristics (Rogers, 2003; Sia et al., 2004; Tornatzky and Klein, 1982).

Adoption costs include the required financial and human resources in implementing and using green practices. Costs have been long posited as a barrier for the adoption of innovations (Rogers, 2003; Iacovou et al., 1995; Torantzky and Klein, 1982). However, some researchers argue that high adoption costs may motivate innovation adopters to treat the innovation more seriously and implement it more actively in order to make the innovation more cost-effective (Cooper and Zmud, 1990; Rogers, 2003). Unfortunately, there is still lack of empirical evidence for this argument because previous studies on innovation infusion have not yet taken adoption costs into account. The present study argues that high adoption cost will make a firm treat the green practice more seriously and reinforce the infusion of the green practice within the firm. Therefore, the following hypothesis is proposed:

H1: *Adoption cost of green practices has a positive influence on green practice infusion in Chinese logistics companies.*

Complexity is the degree to which an innovation is perceived to be relatively difficult to understand and use. It will increase the difficulty in knowledge transfer and

innovation diffusion (Rogers, 2003), and is usually hypothesized to be negatively related to innovation diffusion (Tornatzky and Klein, 1982). Green practices incorporate both tacit and explicit knowledge. The tacit knowledge may be inherent in identifying sources of pollution, reacting quickly to accidental spills, and proposing preventive solutions (Boiral, 2002). It leads to the ambiguity of the practices. Ambiguity is a major barrier to the transfer of best practice within a firm (Szulanski, 1996). A firm is apt to implement innovation when knowledge is shared easily within the organization. Efficient knowledge sharing can lead to better innovative capabilities in terms of higher order learning, and consequently can improve organizational performance including environmental management effectiveness (Etzion, 2007). A green practice with high complexity contains a lot of tacit knowledge that requires laborious efforts to learn and diffuse. The difficulty in learning and sharing tacit knowledge makes it relatively difficult to infuse a green practice. Therefore, the following hypothesis is proposed:

H2: *Complexity of green practices has a negative influence on green practice infusion in Chinese logistics companies.*

Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, experiences, and needs of the firms (Rogers, 2003). Compatibility is relevant to green practice diffusion. Because several green practices are additions to companies' current technologies and processes, diffusion of green practices is not a single event but can be described as a process of knowledge accumulation and integration. Green practices that are more compatible to a company's current technologies and processes will be more easily to be diffused within the organization. Dupuy (1997), in a study of Ontario organic chemical industry, found support for the notion that innovations that are additions to existing technology, such as abatement equipment, are most likely to adopt earlier than technologies that are more difficult to incorporate into the production process. Fit between previous experiences and environmental actions may generate a greater environmental effectiveness (Etzion, 2007). To lessen possible objection against the infusion of green practices, a company will be more likely to implement a green practice that is more compatible with the company's current operational knowledge. Therefore, the following hypothesis is proposed:

H3: *Compatibility of green practices has a positive influence on green practice infusion in Chinese logistics companies.*

Relative advantage is the perception that an innovation is more advantageous than its substitute idea. The perceived benefits may be measured in economic and social terms like convenience and satisfaction. Companies are more likely to implement a technology which is able to provide better performance and higher economic gains than the other technologies. Relative advantage is positively related to the diffusion of innovation (Rogers, 2003; Tornatzky and Klein, 1982). Potential organizational benefits of green practices include reduced energy and natural resource consumption, reduced waste and pollutant emission, improved environmental and financial performance, and greater responsiveness to social environmental expectation (Etzion, 2007; Hart, 1995). In a study of the Spanish pulp and paper industry, Del Rio Gonzalez (2005) suggests that economic and financial advantages are important technological characteristics that influence the adoption of clean technologies. The perceived net benefits that the green practice offers will serve as motivations for companies to implement the green practice. Therefore, the following hypothesis is proposed:

H4: *Relative of green practices has a positive influence on green practice infusion in Chinese logistics companies.*

Organizational factors

The organizational context implies the processes and attributes that constrain or facilitate innovation. Several studies have discussed the influences of a variety of organizational characteristics such as quality of human resources, top management's leadership, organizational support, organizational culture and organizational size on innovation diffusion (Damanpour and Schneider, 2006; Taylor and McAdam, 2004), and environmental strategy (Etzion, 2007; Gonzalez-Benito and Gonzalez-Benito, 2006). Sufficient organizational resources and qualified organizational capabilities are two relevant organizational characteristics advancing innovation (Damanpour, 1991; Jeyaraj et al., 2006) and environmental performance (Hart, 1995; Russo and Fouts, 1997). The availability of resources, management support, organizational learning capabilities, and human resources will influence the adoption of green practices (Alvarez-Gil et al., 2007; Lee, 2008). The followings only introduce the quality of human resources, organizational support, and company size because they are organizational resource-related variables widely analyzed in the literature.

The quality of human resources is an essential factor influencing innovation diffusion (Fichman and Kemerer, 1997; Tornatzky and Fleischer, 1990). Qualified human resources are helpful to diffuse innovations because of their competent learning capabilities. Implementing green practices is a complex process requiring cross-disciplinary coordination and significant changes in the existing operation process (Russo and Fouts, 1997). It is intensive in human resources and depends on the development and training of tacit skills through the employees' involvement (Hart, 1995; Del Brio and Junquera, 2003). A company with higher innovative capacity will be more likely to successfully implement an advanced environmental strategy (Christmann, 2000; Judge and Elenkov, 2005). The recipient's lack of absorptive capacity is one of the major barriers to the transfer of technical knowledge within a firm (Szulanski, 1996). To overcome knowledge barriers to green practice infusion, employees need extensive, specialized training to learn the principles underlying the innovation. Employees with competent learning capabilities will be apt to increase their absorptive capacity through training programs that can advance green practice infusion. Therefore, the following hypothesis is proposed:

H5: *Quality of human resources has a positive influence on green practice infusion in Chinese logistics companies.*

Organizational support is the extent to which a company helps employees use green practices. Providing incentive for innovation diffusion and ensuring the availability of financial and technical resources for innovation have positive effects on the implementation of innovation (Damanpour and Schneider, 2006; Jeyaraj et al., 2006; Lee et al., 2005). For the development of environmental management, organizational support is essential because the employees will be motivated to implement green behavior and the resources required for adopting green practices will be more easily available. Also, the top management plays an essential role in organizational support. Many green practices require the collaboration and coordination of different departments and divisions during diffusion process. To ensure successful diffusion, green initiatives are usually endorsed and encouraged from the top management (Gonzalez-Benito and Gonzalez-Benito, 2006). The central task of top management is to obtain resources and assemble them into organizational capabilities so that the company is able to implement green practices to achieve environmental competitive advantage (Judge and Elenkov, 2005). Therefore, the following hypothesis is proposed:

H6: *Organizational support has a positive influence on green practice infusion in Chinese logistics companies.*

Company size has been repeatedly taken as a relevant organizational characteristic influencing companies' innovation diffusion (Frambach and Schillewaert, 2002; Rogers, 2003) as well as environmental activities (Del Brio and Junquera, 2003; Etzion, 2007; Gonzalez-Benito and Gonzalez-Benito, 2006). In general, large companies tend to adopt innovations and green practices more easily than small ones because they have sufficient resources and strong infrastructures. Small companies, in contrast, may suffer from the lack of financial resources and professionals, which results in difficulties in adopting green practices. However, some researchers argue that, due to less flexible structure, lower ability to adapt and more difficulty in assimilating change, larger companies may be more difficult than smaller companies in the infusion of innovations (Dampour and Schneider, 2006; Zhu et al., 2006). Therefore, the following hypothesis is proposed:

H7: *Company size has a negative influence on green practice infusion in Chinese logistics companies.*

Environmental factors

The environmental factors in this study refer to the standard conceptualization of external environment in the organizational behavior literature. The external environment in which a company conducts its business is an important factor affecting innovation adoption and environmental strategy. Certain environmental variables such as environmental uncertainty, environmental munificence, governmental support, industry type, competition, and network relations are often discussed in the literature of innovation diffusion (Frambach and Schillewaert, 2002; Damanpour and Schneider, 2006; Jeyaraj et al., 2006; Tornatzky and Fleischer, 1990; Zhu et al., 2006) and environmental management (Etzion, 2007; Gonzalez-Benito and Gonzalez-Benito, 2006a). Environmental uncertainty and external resource availability are consistently regarded as two primary environmental factors influencing innovation diffusion and environmental strategy (Aragon-Correa and Sharma, 2003; Jeyaraj et al., 2006; Rothenberg and Zyglidopoulos, 2007; Tornatsky and Fleischer, 1990). The government plays an important role in supporting resources for innovation adoption (Lee, 2008; Li and Atuahene-Gima, 2002; Scupola, 2003). Stakeholder pressure is another relevant environmental factor influencing organizational environmental behaviors, and is widely involved in

research on environmental issues (Buysse and Verbeke, 2003; Sharma and Henriques, 2005). The present study analyzes possible influences of environmental uncertainty, governmental support, and stakeholder pressure on green practice infusion.

Environmental uncertainty refers to frequent and unpredictable changes in customer preferences, technological development, and competitive behavior perceived by the managers. It has been viewed as the most relevant environmental characteristic that affects a firm's decision making (Li and Atuahene-Gima, 2002). Managers facing uncertain business environments tend to be more proactive and use more innovative strategies than managers in less turbulent environments. Under high environmental uncertainty, companies will attempt to gather and process information frequently and rapidly to address environmental changes (Gupta and Govindrajan, 1991), and also tend to pay more efforts on innovation and increase the rate of innovation to maintain a competitive advantage (Damanpour, 1991; Kimberly and Evanisko, 1981; Zhu and Weyant, 2003). Implementing green practices can be regarded as a technical innovation process that can improve a company's environmental performance. Companies are more likely to invest in resources to implement green practices to generate the capacity to improve environmental performance in uncertain environments (Aragon-Correa and Sharma, 2003; Rothenberg and Zyglidopoulos, 2007). The infusion of green practices is expected to be positively associated with the perceived environmental uncertainty. Therefore, the following hypothesis is proposed:

H8: *Environmental uncertainty has a positive influence on green practice infusion in Chinese logistics companies.*

Governmental support is a relevant environmental factor influencing technical innovation. The governments can advance technical innovation through several encouraging policies such as providing financial incentive, technical resources, pilot projects, and tax breaks (Tornatzky and Fleischer, 1990; Scupola, 2003). Implementing green practices relies to some extent on the availability of external resources. Munificence of resources in the business environment increases the degree to which a company engages in environmental management (Aragon-Correa and Sharma, 2003; Rothenberg and Zyglidopoulos, 2007). The government can raise the munificence by providing governmental subsidies or tax incentives for alternative energy technologies, bank financing at lower rates for environmentally friendly technologies, and lower insurance premiums for lower environmental risks (Aragon-

Correa and Sharma, 2003). Lee (2008), in a study of Korean small and medium-sized enterprises, also suggests that governmental support in green initiatives has a positive influence on the company's willingness to participate in the green supply chain. A positive association between green practice infusion and governmental support is expected. Therefore, the following hypothesis is proposed:

H9: *Governmental support has a positive influence on green practice infusion in Chinese logistics companies.*

Stakeholders are individuals or groups who affect a company's activities and are also affected by the company's activities. Stakeholder pressure is regarded as the most prominent factor influencing a company's environmental strategy (Buysse and Verbeke, 2003; Gonzalez-Benito and Gonzalez-Benito, 2006a; Sharma and Henriques, 2005). According to the stakeholder theory, organizations carry out activities to satisfy their main stakeholders. Among various groups of stakeholders, customers and regulators are arguably viewed as a company's most important stakeholders (Christmann, 2004; Etzion, 2007). A body of research reveals the positive relationships between firms' environmental activities and customer and regulatory pressure (e.g., Christmann, 2004; Lee, 2008; Wong and Fryxell, 2004). The infusion of green practices will be positively associated with customer and regulatory pressure. Therefore, the following hypotheses are proposed:

H10: *Regulator pressure has a positive influence on green practice infusion in Chinese logistics companies*

H11: *Customer pressure has a positive influence on green practice infusion in Chinese logistics companies.*

Methodology

To examine the influences of determinant factors on green practice infusion, this paper collected data by means of mailing questionnaires to logistics service providers in China. The logistics industry plays an important role in the Chinese economy. Logistics companies provide logistics services for their customers, which include warehousing, transportation, inventory management, order processing, and packaging. With the fast growth in economy, the demand for logistics services has been growing significantly in China. Also, the environmental impact of the logistics practices has been an important issue in China. Many logistics operations often leads

to several negative environmental impacts, including air pollutants, waste disposal, and fuel consumption. Logistics companies need to address much effort on environmental issues.

Samples were randomly drawn from a list of logistics companies provided by the logistics associations in China. Logistics companies carry out logistics activities for their customers, including warehousing, transportation, inventory management, order processing, and packaging. The sampled companies were contacted via telephone and e-mail to confirm the names of respondents and their mailing addresses. One thousand samples were randomly drawn from a list of logistics companies in Shanghai. Questionnaires were mailed to these sampled companies' owners or senior managers who are familiar with the company's environmental activities. Two weeks after the questionnaires were mailed, a follow-up to the sampled companies was conducted to remind them of the importance of their responses and thank them for their assistance. In total, 314 completed questionnaires were returned. Of these respondents, 21 unusable questionnaires were excluded. The overall response rate is 29.3 percent. Among the respondents, approximately 82 percent of them have less than 300 employees. Most logistics companies in China belong to small and medium-size enterprises.

To evaluate the non-response bias, the wave analysis was used which assumes that late respondents tend to be more similar to non-respondents than early respondents in mail surveys (Armstrong and Overton, 1977). The non-response bias was tested by comparing respondents who responded readily to the survey with those who responded after the follow-up step is taken. Because comparisons of survey results reveal no significant differences between the two groups in the level of variables, the non-response bias is not significant in the study.

The questionnaire was developed in a two-stage process. First, an initial questionnaire was designed based on a review of related literature and a discussion with some experts in environmental management. Second, the initial questionnaire was modified by accommodating some logistics managers' suggestions to ensure that each item adapts to the logistics industry and is interpreted as expected. Afterward the final version of the questionnaire was administered to sampled logistics companies with business models conforming to the logistics services.

The major constructs outlined in the present research framework include green practice infusion, and determinant factors. The green practices commonly used in

the logistics industry include consolidating shipments, disposing waste responsibly, purchasing ecological products, reducing energy consumption, reducing solid/water waste and emissions, using cleaner transportation methods, and using recyclable packaging (Gonzalez-Benito and Gonzalez-Benito, 2006; Lin and Ho, 2011; Murphy and Poist, 2003). Infusion refers to the extent to which an innovation's features are in widespread usage in a complete and sophisticated way (Fichmen 2001). According to innovation infusion literature (Cooper and Zmud, 1990; Yan and Fiorito, 2007; Yu et al., 2009; Zhu et al. 2006; Zmud and Apple, 1992), we conceptualized infusion as the extent to which major logistics operations have integrated with green practices. Each sampled company was asked to score the degree of infusion of green practices according to a seven-point scale anchored by "not at all" and "to a great extent".

The measurement of determinant factors was developed according to innovation diffusion literature (Rogers, 2003; Tornatzkey and Fleischer 1990) and green practice adoption model proposed by Lin and Ho (2011). Adoption cost was measured according to the financial resources required to evaluate the green practices and start to utilize the green practices. Complexity was measured by whether the green practices would be learned and used easily. Compatibility was measured based on the degrees of perceived fitness between the green practice and the company's existing technologies and processes. Relative advantage was measured by whether the green practice could increase environmental and economic performance. The quality of human resources was measured according to employees' learning capabilities. Organizational support was measured according to the degrees of the company's resource supports and leaders' attitudes toward environment issues. The company size was measured by the number of employees. The environmental uncertainty was measured according to the degrees of changes in competitors' innovative abilities, customers' requirement, and the development of new technologies. Governmental support was measured by whether the government provides financial and technical supports for adopting green practices. Customer pressure and regulatory pressure was measured by asking the respondents to score the environmental pressure exerted by customers and regulators.

The determinant factors were measured using seven-point Likert scales anchored by "strongly disagree" and "strongly agree". The measurement items of determinant factors were submitted to factor analysis with varimax rotation. Factors with eigenvalues greater than 1.0 are summarized in Table 1. 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 0.7743, which implies that the sampling results are reliable (Nunnally, 1978).

Table 2 shows the means, standard deviations and correlations for the variables. The determinant factors are not highly correlated, which implies that multicollinearity may not be significant in the following regression analysis. Furthermore, the high correlations between green practice infusion and most of the determinant factors give initial evidence of the hypotheses: technological, organizational, and environmental factors are associated with the organizational infusion of green practices.

Table 1: Measurement Items for the Determinant Factors

Determinant Factors	Factor Loading	Cronbach's α
Technological Factors (Total explained variance = 72.63% ; Cronbach's α = 0.8598)		
Adoption cost		
We spend a lot of money to evaluate the green practices.	0.788	
The cost in starting using the green practices is expensive.	0.762	
We spend a lot of time to evaluate the green practices.	0.705	0.8179
Complexity		
Using the green practices needs many experiences.	0.804	
Learning the green practices is difficult.	0.759	
Sharing the knowledge of the green practices is difficult.	0.698	0.8663
Compatibility		
The green practices are compatible with our existing logistics operations.	0.826	
The green practices are consistent with our company's values.	0.767	
Integrating the green practices with company's existing system is easy.	0.701	0.8802
Relative advantage		
The green practices can provide better environmental performance.	0.793	
The green practices can provide higher economic benefits.	0.775	
The green practices can enhance our company's reputation.	0.689	0.8395
Organizational Factors (Total explained variance = 75.87% ; Cronbach's α = 0.8906)		
Quality of human resources		
Employees are capable of using new technologies to solve problems easily.	0.841	
Employees are capable of providing new ideas for our company.	0.812	
Employees are capable of learning new technologies easily.	0.739	
Employees are capable of sharing knowledge with each others.	0.694	0.8847
Organizational support		
Top management encourages employees to learn green knowledge.	0.850	
Our company provides rewards for employees' green behavior.	0.809	
Top management can help employees dealing with environmental issues.	0.758	
Our company provides resources for employees to learn green knowledge.	0.706	0.8951
Environmental Factors (Total explained variance = 71.89% ; Cronbach's α = 0.8297)		
Environmental uncertainty		
Predicting competitors' behavior is difficult.	0.738	
Customers' preferences vary frequently.	0.667	

The advance in new logistics service modes is quickly.	0.605	0.7743
Governmental support		
Government provides financial support for adopting green practices.	0.842	
Government helps training manpower with green logistics skills.	0.834	
Government provides technical assistance for adopting green practices.	0.725	0.8035
Regulatory pressure		
Government sets environmental regulations for logistics operations.	0.793	
Industrial associations require us to conform to environmental regulations.	0.718	0.8674
Customer pressure		
Our customers require us to improve environmental performance.	0.813	
Caring for the environment is an important consideration for our customers.	0.745	0.8317
Total Cronbach's α = 0.8693		

Table 2: Result of correlation analysis

Variables	Means	Std	1	2	3	4	5	6	7	8	9	10	11	12
1. Adoption cost	4.52	1.79	1.00											
2. Complexity	4.41	1.90	0.11	1.00										
3. Compatibility	4.25	2.06	0.12	0.03	1.00									
4. Relative advantage	4.92	1.28	0.09	0.06	0.11	1.00								
5. Quality of human resources	4.73	1.34	0.06	0.08	0.07	0.04	1.00							
6. Organizational support	4.97	1.15	0.12	0.05	0.08	0.10	0.19	1.00						
7. Company size [a]	4.81	1.47	0.04	0.02	0.04	0.09	0.13	0.18	1.00					
8. Environmental uncertainty	4.08	2.05	0.02	0.06	-0.02	-0.01	0.09	0.12	0.05	1.00				
9. Governmental support	4.86	1.72	0.06	0.09	0.06	0.08	0.11	0.15	0.06	0.02	1.00			
10. Regulatory pressure	5.17	1.58	-0.02	0.03	0.03	0.06	0.07	0.16	0.12	0.07	-0.06	1.00		
11. Customer pressure	5.03	1.84	0.05	0.07	0.03	0.04	0.09	0.10	0.11	-0.03	0.02	0.09	1.00	
12. Green practice infusion	4.79	1.63	0.21	-0.36	0.54	0.59	0.51	0.64	-0.14	-0.16	0.56	0.46	0.29	1.00

[a] *Natural logarithm of the number of employees*

Because a single informant technique was used in data collection, the study may be subjected to the potential for common method bias by artificially inflating observed relationships between variables. We used Harman's single factor test (Podsakoff, MacKenzie, Lee and Podsakoff, 2003) to check the potential common method bias. If common method bias exists, a single factor will emerge from a factor analysis of all survey items, or one general factor that accounts for most of the variance in an unrotated factor structure will result. The analysis revealed more than one factors with eigenvalues greater than 1.0, and the first factor accounted for only about 32 percent of the variance. The results indicated that common method bias was not a problem in the study.

Research Findings and Discussions

To test proposed research hypotheses, the regression analysis is used in the study, which takes the eleven determinant factors as independent variables and the infusion of green practices as the dependent variable. The regression analysis is a statistical process for estimating the relationship between a dependent variable and several independent variables. Before conducting the regression analysis, the regression assumptions of homoescedasticity, linearity, normality, independence of residuals, and the absence of multicollinearity are tested, and these assumptions are all satisfied. Table 3 shows the standardized results of the regression analysis. The regression results reveal that complexity, compatibility and relative advantage of green practices, quality of human resources, organizational support, governmental support and regulatory pressure exhibit significantly influences on green practice infusion for the logistics companies in China. The influences of adoption cost, company size, environmental uncertainty and customer pressure on logistics companies' green behavior are not significant. Except the hypotheses *H1*, *H7, H8* and *H11*, all the other hypotheses are supported.

Table 3: Standardized Regression Results for the Infusion of Green Practices

Dependent variables: Infusion of Green Practices		
Predictors	Standardized Coefficient β	*t*
Technological factors		
Adoption cost	0.089	1.135
Complexity of technology	-0.124	-2.109*
Compatibility of technology	0.184	3.274**
Relative advantage of technology	0.187	3.986**
Organizational factors		
Quality of human resources	0.179	2.979**
Organizational support	0.201	4.211**
Company size	-0.061	-1.004
Environmental factors		
Environmental uncertainty	-0.074	-1.084
Governmental support	0.183	3.315**
Regulatory pressure	0.175	2.843**
Customer pressure	0.098	1.241
R^2	0.617	
adj R^2	0.592	
F	24.33**	

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

To advance green practice infusion, companies can attempt to improve their organizational learning capabilities, and make organizational resources easily available for their employees. In addition to being a regulator, the government should provide sufficient financial, technical and educational resources for green practice infusion within the company.

Adoption costs include the required financial and human resources in implementing green practices. Costs have been long posited as a barrier for the adoption of innovations. However, some researchers argue that high adoption costs may motivate innovation adopters to treat the innovation more seriously and implement it more actively in order to make the innovation more cost-effective (Rogers, 2003). The present study found that adoption cost did not have significantly influences on green practice infusion. Complexity is the degree to which an innovation is perceived to be relatively difficult to understand and use. It will increase the difficulty in knowledge transfer. Green practices incorporate both tacit and explicit knowledge. The tacit knowledge may be inherent in identifying sources of pollution, reacting quickly to accidental spills, and proposing preventive solutions (Boiral, 2002). A green practice with high complexity contains a lot of tacit knowledge that requires laborious efforts to learn and diffuse. The difficulty in learning and sharing tacit knowledge makes it difficult to infuse a green practice. Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, experiences, and

needs of the firms. Because several green practices are additions to companies' current technologies and processes, diffusion of green practices is not a single event but can be described as a process of knowledge accumulation and integration. Green practices that are more compatible to a company's current technologies and processes will be more easily to be diffused within the organization. Relative advantage is the perception that an innovation is more advantageous than its substitute idea. The perceived net benefits that the green practice offers will serve as motivations for companies to implement the green practice.

The quality of human resources is an essential factor influencing innovation diffusion. Qualified human resources are helpful to diffuse innovations because of their competent learning capabilities. Implementing green practices is a complex process requiring cross-disciplinary coordination and significant changes in the existing operation process. To overcome knowledge barriers to green practice infusion, employees need extensive, specialized training to learn the principles underlying the innovation. Organizational support is the extent to which a company helps employees use innovations. Providing incentive for innovation diffusion and ensuring the availability of financial and technical resources for innovation have positive effects on the implementation of innovation. For the development of environmental management, organizational support is essential because the employees will be motivated to implement green behavior and the resources required for adopting green practices will be more easily available. Company size has been repeatedly taken as a relevant organizational characteristic influencing companies' innovation diffusion as well as environmental activities. In general, large companies tend to adopt innovations and green practices more easily than small ones because they have sufficient resources and strong infrastructures. Small companies, in contrast, may suffer from the lack of financial resources and professionals, which results in difficulties in adopting green practices. However, some researchers argue that, due to less flexible structure, lower ability to adapt and more difficulty in assimilating change, larger companies may be more difficult than smaller companies in the infusion of innovations (Dampour and Schneider, 2006). The present study found that company size did not have significantly influences on green practice infusion.

Environmental uncertainty refers to frequent and unpredictable changes in customer preferences, technological development, and competitive behavior perceived by the managers. It has been viewed as the most relevant environmental characteristic that affects a firm's decision making. The present study found that environmental

uncertainty did not have significantly influences on green practice infusion. Governmental support is a relevant environmental factor influencing technical innovation. Implementing green practices relies to some extent on the availability of external resources. The government can raise the munificence by providing governmental subsidies or tax incentives for alternative energy technologies, bank financing at lower rates for environmentally friendly technologies, and lower insurance premiums for lower environmental risks (Aragon-Correa and Sharma, 2003). Stakeholder pressure is regarded as the most prominent factor influencing a company's environmental strategy. According to the stakeholder theory, organizations carry out activities to satisfy their main stakeholders. The infusion of green practices was positively associated with regulatory pressure.

Conclusions

More than two decades of economic reforms have brought China unprecedented economic growth. While China continues to develop into a global manufacturing base and a huge consumer market, it suffers from various serious environmental problems such as air pollution, energy waste, and water pollution. The environmental crisis has led to some moral doldrums in China. To mitigate the environmental degradation in China, the Chinese government has stipulated several environmental policies, and many companies operating in China have begun to adopt a variety of environmental management practices. To help organizations implementing green practices successfully, it is necessary to give an analysis on the factors influencing green practice infusion in organizations. An understanding of the determinant factors is essential for practitioners to best implement green practices.

Although a body of research has proposed several factors influencing green practice adoption, none of them analyzed the factors influencing green practice infusion. This study conducts a questionnaire survey on the factors affecting green practice adoption for logistics companies in China. The determinant factors are classified into environmental, organizational and technological factors. The research findings reveal that regulatory pressure, governmental support, organizational support, quality of human resources, and relative advantage and compatibility of green practices have significantly positive influences on organizational infusion of green practices in Chinese logistics companies. Therefore, green practice providers should pay more efforts to increase the explicitness and benefits of green practices while providing green technologies, equipments and services for their clients. Logistics companies themselves need to sustain more organizational support for employees'

green behavior, and improve their quality of human resources. In addition to being a regulator, the government can provide sufficient resources for logistics companies to implement green practices

The contributions of this paper include providing logistics service providers guidelines for increasing their green competitiveness, providing the government suggestions in designing environmental policies for the logistics industry, contributing to an insight into the infusion of green practices in the logistics industry, and broadening the scope of research both on environmental management and logistics issues.

One limitation to this study is that the results may suffer from the respondent bias because the questionnaire survey was used in the study. In addition, because this paper focuses on organizational infusion of green practices in Chinese logistics companies, the research findings may be limited in their generalizability. Different countries and industrial sectors may lead to conclusions different from the present study. Future studies can use the proposed model to other countries and industrial sectors.

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