

**Capturing the Economic Benefits of Green Logistics: The Roles of Visibility and  
Exploratory Links**

**Benn Lawson**  
University of Cambridge  
Cambridge Judge Business School  
Trumpington Street  
Cambridge, UK CB2 1AG  
Tel: +44-122-376-0587  
e-mail: [b.lawson@jbs.cam.ac.uk](mailto:b.lawson@jbs.cam.ac.uk)

**Brian S. Fugate, Ph.D.**  
Colorado State University  
Department of Management  
223 Rockwell Hall  
Fort Collins, CO 80524  
(970) 491-4359  
[brian.fugate@colostate.edu](mailto:brian.fugate@colostate.edu)

**Kenneth J. Petersen**  
John H. Dove Professor of Logistics  
University of Tennessee  
Department of Marketing and Logistics  
Knoxville, TN 37996-0530  
Tel: 865-974-9451  
e-mail: [Petersen@utk.edu](mailto:Petersen@utk.edu)

**Paul D. Cousins**  
University of Manchester  
Manchester Business School  
Manchester M15 6PB  
Tel: +44-161-306-3459  
e-mail: [paul.cousins@mbs.ac.uk](mailto:paul.cousins@mbs.ac.uk)

# **Capturing the Economic Benefits of Green Logistics: The Roles of Visibility and Exploratory Links**

## **1. Introduction**

An increasing amount of scholarship and managerial attention has focused on the response of firms to today's immense environmental concerns (Sarkis, Zhu and Lai, 2011). Much research has been focused on understanding the performance implications of green supply chain management (GSCM) practices. A growing proportion of this research suggests a positive link between GSCM and financial performance (e.g., Montabon, Sroufe and Narasimhan, 2007; Rao and Holt, 2005; Carter, Kale and Grimm, 2000). However, others suggest the GSCM-performance link is more complicated, with some results indicating the relationship is neutral or even negative (e.g., Jacobs, Singhal and Subramanian, 2010; Zhu and Sarkis, 2004).

Further, research suggests that some firms may undertake environmental practices to gain legitimacy with external stakeholders without necessarily improving the natural environment (Dacin, Oliver and Roy, 2007). They may seek the appearance of environmental stewardship through superficial practices in attempts to provide an image that satisfies external institutional forces (Bansal and Clelland, 2004; Suchman, 1995). Yet empirical support for the positive link between environmentally friendly supply chain practices and realized improvements to the environment is relatively scarce (e.g., Zhu and Sarkis, 2004). Therefore, this research empirically assesses GSCM's impact on not only firm cost performance, but also environmental performance.

In addition, pressures from regulatory bodies, governments, nongovernmental organizations, trade associations, and other supply chain entities with environmental interests is viewed as the primary driver of firms implementing GSCM (Tate, Dooley and Ellram, 2011). Indeed, forces from external environmental stakeholders result in significant

motivation for firms to adopt GSCM practices (Sarkis, Gonzalez-Torre and Adenso-Diaz, 2010). However, the organizational culture and norms that a firm pursues to satisfy these external stakeholder influences has been largely ignored. This external environmental orientation is an important mediator in the external stakeholder pressure-GSCM link. It is the strategic emphasis on promoting a firm culture that protects environment that drives consistent environmental organizational routines (Banerjee, 2011; Deshpande and Webster, 1989) necessary for effective GSCM. Accordingly, this research adapts the concept of external and internal environmental orientation from business ethics research (Fraj-Andrés, Martinez-Salinas and Matute-Vallejo, 2009) to empirically examine it as a key antecedent to GSCM.

Further, success of organizational practices, such as GSCM, depends on the development and effective deployment and maintenance of complementary capabilities (Barney, 2001; Christmann, 2000; Russo and Fouts, 1997). Zhu et al. (2008) suggests that the firm's propensity and ability to capture and leverage relevant knowledge and expertise from all appropriate supply chain participants enables effective and efficient GSCM. Thus, we hypothesize and test three moderators to the GSCM-performance relationship. First, we examine supply chain ecocentricity, which refers to the firm's proclivity to engage and learn from environmental external stakeholders (Pagell and Wu, 2009). Second, we investigate the level of environmental supply chain visibility (Setterstrom, 2008). Third, we assess the moderating influence of environmental management systems, which measure and reward alignment of employee actions with environmental and financial performance (Sarkis, Gonzalez-Torre and Adenso-Diaz, 2010).

A review of the literature builds the support for hypotheses among external and internal environmental orientation, green supply chain management, environmental and cost performance, and the moderating relationships of supply chain ecocentricity, environmental

supply chain visibility, and environment management systems. These hypotheses are empirically tested through a survey of 248 manufacturing firms operating in the United Kingdom. This is followed by the results of the hypotheses tests. Finally, this research closes with theoretical and managerial implications followed by future research.

## **2. Literature review and hypotheses development**

Stakeholder theory posits that firms are responsible for a variety of stakeholders and thus respond to their claims as an attempt to legitimize its existence (Freeman, 1984). In particular, pressures from stakeholders with environmental interests motivate firms to become more *oriented* toward environmental concerns (Wu and Pagell, 2011; Sarkis, Gonzalez-Torre and Adenso-Diaz, 2010; Eesley and Lenox, 2006; Buysse and Verbeke, 2003). Such an orientation creates a firm “posture” that prioritizes decision-making in a way that emphasizes impacts on the environment (Wu and Pagell, 2011, p. 585). Firms with an environmental orientation will seek to satisfy external influences for environmentally friendly supply chain practices and to adapt the firm’s internal orientation to environmental values. Other critical external stakeholders, perhaps the most fundamental (Sarkis, Gonzalez-Torre and Adenso-Diaz, 2010), include those who have financial investments in the firm (Ramchander, Schwebach and Staking, 2012; Adams, Licht and Sagiv, 2011). Consequently, firms will attempt to align their economic objectives with environmental performance by orienting their organizational culture and resulting management practices in a manner that is compatible with the simultaneous achievement of environmental and financial improvements.

Rooted in stakeholder theory, we develop a conceptual model relative to a firm's environments, conduct, and consequences (Figure 1), where environmental and cost performance (consequence) is posited as a derivative of the relationship between the firm’s green supply chain management practices (conduct) and the internal and external environments in which it operates. Environmental orientation and environmental supply

chain practices are posited to be closely linked concepts that involve integrating environmental values into the firm's internal culture and translating this specific commitment into specific practices at the operational levels. Additionally, we draw from organizational learning research (Christmann, 2000) which suggests that success in achieving desired outcomes (financial and environmental) improves when coupled with complementary capabilities (Zhu et al., 2008). Therefore, we build on existing literature that highlights the following complementary capabilities as important moderators to the GSCM-performance relationship: supply chain ecocentricity, environmental supply chain visibility, and environmental management systems.

-----  
Insert Figure 1 About Here  
-----

## ***2.1 Environmental orientation and green supply chain management***

### ***2.1.1 Green supply chain management***

Previous research highlights a number of environmental practices relevant to the management of physical input and output flows of industrial firms (Jayaraman, Klassen and Linton, 2007; Linton, Klassen and Jayaraman, 2007; Jayaraman, Linton and Klassen, 2005). A variety of terms have been used to describe these initiatives such as supply and demand sustainability (Cruz and Matsypura, 2009), green or environmental purchasing/procurement (Ellram et al., 2002; Min and Galle, 2001), and green or environmental logistics (González-Benito and González-Benito, 2006; Murphy, Poist and Braunschweig, 1996). We use the term green supply chain management (GSCM) which refers to the extent to which firms have integrated environmental responsibility into their supply chain decisions.

### ***2.1.2 Environmental orientation: internal and external***

Adoption of GSCM is influenced by the firm's orientation to acknowledge and affirm the environmental contributions of its supply chain management actions. Environmental orientation refers to the firm's *recognition* of the need to reduce the environmental impact of its productive activities (Banerjee, Iyer and Kashyap, 2003). It is an organizational culture or set of norms that acknowledges the importance of green values and environmental issues facing their firm (Fraj-Andres et al. 2008). Underlying the premise of the environmental orientation concept is the notion that effective, consistent environmental practices requires the firm to place strategic emphasis on promoting an organizational culture that protects the environment (Banerjee, 2011; Deshpande and Webster, 1989).

A firm's environmental orientation has both an external and internal component (Banerjee, 2002). An external environmental orientation (EEO) refers to managerial perceptions about the dependence of the firm's economic health on environmental protection (Banerjee, Iyer and Kashyap, 2003). It expresses the degree to which environmental objectives and stakeholders' objectives are complementary and not rival interests. This orientation is based on the perceptions of managers of whom the essential stakeholders are as well as which pressing environmental issues merit a response in order to balance the needs of all relevant and important stakeholders (Baker and Sinkula, 2005). Consequently, firms with a high degree of EEO demonstrate an understanding that the financial viability of the organization must be aligned with environmental values. They will see environmental preservation as vital to their firm's survival.

Firms with an EEO, therefore, will be motivated to implement ecological values within the firm's culture partially with the aim of satisfying their relations with stakeholders who demand a shift in the firm's environmental behavior (Fraj-Andrés, Martínez-Salinas and Matute-Vallejo, 2009; Pagell and Wu, 2009). According to institutional theory (DiMaggio and Powell, 1983), firms with this orientation will be motivated to adopt GSCM in order to

be perceived as having legitimate environmental practices, aligning with external agencies that may be coercively influencing the practice of environmental activities (Rivera-Camino, 2007), and being competitive in terms of industry/competitor environmental standards (Foerstl et al., 2010; Reuter et al., 2010). These firms will be oriented to implement organizational norms that drive the development of GSCM in order to signal environmental values to their external constituents.

**H1a: An external environmental orientation is positively associated with green supply chain management.**

Internal environmental orientation (IEO) refers to a firm's desire to make environmental values a corporate goal and to promote these ideals throughout all levels of the corporate hierarchy, functions, and processes (Shrivastava, 1995b; a). IEO emphasizes the firm's internal values, standards of ethical behavior, and commitment to ecological ideals (Banerjee, Iyer and Kashyap, 2003). This orientation may be informally expressed in corporate cultures through employee norms and behaviors which is then manifested in the firm's actions ((Baker and Sinkula, 2005). The collective consciousness of environmentalism in the firm results in values, beliefs, and tacit knowledge that is fused and internalized into the firm's strategies, tactics, and operations (Banerjee, Iyer and Kashyap, 2003). Consequently, firms with a high degree of IEO will exhibit environmental values that result in GSCM through formally codified in the goals, policies, communications between different departments and hierarchical levels in the firm (Fraj-Andrés, Martinez-Salinas and Matute-Vallejo, 2009), and internal structures such as the appointment of environmental managers and implementation of environmentally focused projects (Stone and Wakefield, 2000).

**H1b: An internal environmental orientation is positively associated with green supply chain management.**

***2.2 Environmental and cost performance***

Research provides evidence that GSCM is positively related to environmental performance (Zhu et al., 2008; Rao and Holt, 2005; Russo and Fouts, 1997). Researchers have found that firms implementing environmental supply chain processes experience improved environmental performance such as significantly reduced waste (Melnik, Sroufe and Calantone, 2003a) such as air emissions and other pollutants, waste water, and hazardous material (Pullman, Maloni and Carter, 2009; Zhu and Sarkis, 2004). For instance, prioritizing shipment consolidation in transportation scheduling and routing (Wu and Dunn, 1995) facilitates optimization of vehicle capacity which reduces the emission of contaminating gases (González-Benito and González-Benito, 2006). Prioritizing cleaner transportation modes and technologies should decrease pollutants (Byrne and Polonsky, 2001). Implementing environmental criteria in selecting suppliers and purchasing products should not only improve performance of the environment in proximity to the firm's inbound and outbound activities, but also those of their suppliers (Handfield et al., 2002). These and other environmental supply chain practices such as ecological materials for primary packaging, reusable shipping containers, and recycling distribution systems (González-Torre, Adenso-Díaz and Artiba, 2004; Rogers and Tibben-Lembke, 2001) provide support for the positive environmental impact of GSCM.

**H2a: Green supply chain management is positively associated with environmental performance.**

While some firms may seek environmental performance improvements to satisfy legitimacy, coercive, and social pressures, many are reluctant to aggressively implement GSCM due to a perception that minimal evidence exists that the benefits outweigh the costs of GSCM (Montabon, Sroufe and Narasimhan, 2007). Indeed, Friedman (1970) contended it is not in the best interest of shareholders and degradation of firm performance will result when firms undergo environmental expenses beyond those required for regulatory compliance. However, the cumulative evidence of previous research provides support that

GSCM leads to improved economic performance (e.g., Pullman, Maloni and Carter, 2009; Zhu and Sarkis, 2004). For instance, Montabon et al.'s (2007) study comprised of environmental and business performance data from 45 corporate reports demonstrated significant and positive relationships between environmental management practices and measures of performance. In particular, significant cost advantages can result from environmental improvements (Carter, Kale and Grimm, 2000) such as superior waste management, use of less expensive recycled raw materials, energy consumption (Sroufe, 2003), environmental accidents and number of components in products (Jacobs, Singhal and Subramanian, 2010), and pollution prevention which limits the costs of compliance with environmental regulations (Hart, 1995). Further, research suggests that a firm's financial performance is directly linked to greening of inbound activities and linked to the greening of outbound activities through improved competitiveness (Rao and Holt, 2005). Such improvements resulting from GSCM should, therefore, ultimately provide cost improvements such as reductions in production costs, total product costs, and labor productivity.

**H2b: Green supply chain management is positively associated with cost performance.**

***2.3 Supply chain ecocentricity, environmental supply chain visibility, and environmental management systems***

***2.3.1 Supply chain ecocentricity***

Pagell and Wu's (2009, p. 50) case studies findings suggest that firms which have a proclivity toward environmental sustainability will "reconceptualize who is in the supply chain" such that they will leverage the expertise and skills of environmental external stakeholders. This notion of reconceptualizing the supply chain stems from literature on ecocentricity (Seuring, 2004; Gladwin, Kennelly and Krause, 1995), which suggests firms should consider the well-being of and potential benefits gained from learning from their broader constituents in the environment (social, ecological, and industrial). As noted by

Pagell and Wu (2009) ecocentricity has been discussed in the literature from a theoretical or conceptual perspective, but has not been the subject of empirical research. Accordingly, we examine the moderating effect of supply chain ecocentricity on the performance impacts of green supply chain management. We refer to supply chain ecocentricity as a firm's proclivity to engage and learn from environmental external stakeholders.

The importance of supply chain ecocentricity is evident since treating environmental stakeholders as adversaries and responding to their pressures reactively may result in negative long-term consequences (Pagell and Wu 2009). Firms are pressured by a number of environmentally focused external stakeholders, such as regulatory bodies, government, nongovernmental organizations, and trade associations. Firms that lack supply chain ecocentricity will view these environmental external stakeholders as adversaries (Pagell and Wu 2009). They may associate regulatory bodies and government as coercive pressures (Zhu and Sarkis, 2007) and feel threatened by regulators levying legal action, penalties and fines if they do not comply with environmental regulation (Sarkis, 2010). They may attempt to satisfy the institutional forces in their social context (Dacin et al., 2007) to gain legitimacy with environmental external stakeholders (Bansal and Clelland, 2004; Suchman, 1995) instead of engaging and learning from the latest research.

Thus, their practices to improve environmental performance may be out-of-date with the most current, innovative green supply chain management. If ineffective, such green practices may even be viewed as superficial, "Green Washing" approaches (Laufer, 2003). Ignoring the expertise, such as recently revised standards of environmental conduct and compliance (Tate et al. 2011), from environmental external stakeholders may even result in conducting GSCM that damages rather than improve the environment.

Other business organizations, however, actively seek those capabilities embedded in external stakeholders that can enable substantive environmental improvements (Plambeck,

2007). These partnerships reflect an integrative arrangement in which actors across sectors engage in nonhierarchical processes to achieve mutual goals (Visseren-Hamakers, Arts and Glasbergen, 2011; Van Huijstee and Glasbergen, 2010). Engaging environmental stakeholders may result in obtaining insights about cleaner transportation methods or ecological packaging materials of which the firm was previously unaware. Learning from environmental external stakeholders may facilitate more accurate definitions and measurement of standards for green product purchasing and environmental criteria for supplier selection (Tate, Dooley and Ellram, 2011). Thus, firms with a high level of supply chain ecocentricity will proactively engage environmental stakeholders in these efforts to implement practices that real, measureable environmental performance improvements, which enhances GSCM practices impact on the environment.

**H3a: The positive association between green SCM practices and environmental performance is stronger in firms exhibiting higher levels of supply chain ecocentricity than in firms exhibiting lower levels of supply chain ecocentricity.**

Similarly, engaging and learning from environmental stakeholders should enhance the cost improvements resulting from GSCM efforts. Firms with higher levels of supply chain ecocentricity will be more prone to pay attention to and engage with a broader set of environmental stakeholders. Nontraditional supply chain members such as NGOs, nonprofits, and local governments can offer the newest and most trustworthy expertise in environmental technologies and processes that are most economical (Tate, Dooley and Ellram, 2011)). Such expertise should facilitate planning and operational practices that become embedded in organizational routines, improving efficiencies, whereas in less proactive firms they might be nonexistent (Matos and Hall, 2007). Additionally, gaining access to recent environmental technologies and processes will enable reduced conflicts and confusion among managers implementing GSCM, which in turn, decrease costs because

those environmental supply chain practices that are selected and implemented should be better aligned with more relevant environmental issues (Sarkis et al., 2011). Approaches that foster cooperation and environmental learning from environmental stakeholders should also result in helpful knowledge that mitigates risks in potential legal costs, penalties, and fines associated with GSCM implementation (Banerjee, 2002). Supply chain ecocentricity may even facilitate partnerships with nontraditional environmental supply chain members that assist in off-setting costs of GSCM investments (Pagell and Wu 2009).

**H3b: The positive association between green SCM practices and cost performance is stronger in firms exhibiting higher levels of supply chain ecocentricity than in firms exhibiting lower levels of supply chain ecocentricity.**

### *2.3.2 Environmental supply chain visibility*

Although research has acknowledged the importance of GSCM to environmental and financial performance, the critical role played by visibility of supply chain activities has received relatively minimal attention (Faucheux and Nicolai, 2011; Jenkin, McShane and Webster, 2011; Wang, Yeung and Zhang, 2011; Setterstrom, 2008). Visibility of environmental supply chain practices is important because physical, social and cultural distance grows between supply chain members and their associated activities as supply chains increasingly expand globally (Setterstrom, 2008).

The ability to trace and track the processes involved in producing and distributing products throughout the supply chain enables GSCM to be more effective in making real impacts on the environment. Visibility of supply chain environmental practices helps raise awareness about environmental initiatives by diffusing information through the firm and the supply chain (Faucheux and Nicolai, 2011; Jenkin, McShane and Webster, 2011; Wang, Yeung and Zhang, 2011). This increased awareness should indirectly encourage other firm and supply chain participants to adopt GSCM. For example, research has shown that

improved information asymmetries with customers and suppliers increase the likelihood of firms to adopt GSCM and undergo related certifications (e.g., ISO 14001) (Jiang and Bansal, 2003; Montabon et al., 2000). Increased visibility should also reduce opportunism by individuals within the firm and their supply chain. Without visibility of environmental practices throughout the supply chain, individuals and firms may send false signals of GSCM, without genuine implementation of such practices (Sarkis et al., 2001).

**H4a: The positive association between green SCM practices and environmental performance is stronger in firms exhibiting higher levels of environmental supply chain visibility than in firms exhibiting lower levels of supply chain visibility.**

Environmental supply chain visibility improves environmental reporting of implemented GSCM to external stakeholders, reducing both the costs of reporting as well as the risks of potential environmentally related legal costs, penalties, and fines (Brown, Dillard and Marshall, 2005). Increased visibility of GSCM also minimizes efficiency gaps as redundancies across supply chain members are minimized, as a result of reduced information asymmetry (Haigh and Griffiths, 2008). Research has also shown increased visibility of supply chain activities help incorporate environmental considerations into product design and logistics in a more efficient manner (Watson, Boudreau and Chen, 2010; King, Lenox and Terlaak, 2005).

**H4b: The positive association between green SCM practices and cost performance is stronger in firms exhibiting higher levels of environmental supply chain visibility than in firms exhibiting lower levels of supply chain visibility.**

### *2.3.3 Environmental management systems*

Firms have realized that there are significant technical and organizational culture and change management barriers (Perron et al., 2006) to the successful implementation of GSCM. Environmental management systems (EMS) that measure and reward alignment of employee actions with environmental and financial performance can help overcome these barriers.

With these systems, firms can better monitor and control impacts of GSCM on environmental and cost performance (Sarkis et al. 2011). An EMS typically involve systems and databases that integrate processes and policies for tracking, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders. They document information about pollution control, ecological product and process design, waste minimization, training, and alignment with top management and firm strategies and objectives (Melnyk, Sroufe and Calantone, 2003a). For example, ISO 14001 is one common management system which encompasses auditing, performance evaluation, labeling, life cycle assessment, and product standards (Tibor and Feldman, 1996). The purpose of an EMS is to develop, implement, manage, coordinate and monitor corporate environmental activities to achieve waste reduction and compliance (Sayre, 1996).

The waste reduction goal of a formal environmental management system focuses a firm's activities on the dramatic reduction of negative environmental impact. Numerous GSCM alternatives are available to managers to improve environmental performance. The presence of EMS should facilitate recognition and planning of environmental activities throughout the full range of supply chain processes (raw materials acquisition through distribution). Accordingly, the use of an EMS should result in a more extensive, system-wide environmental impact of GSCM (Melnyk et al., 2003).

**H5a: The positive association between green SCM practices and environmental performance is stronger in firms exhibiting higher levels of environmental management systems than in firms exhibiting lower levels of environmental management systems.**

The primary purpose of EMS's waste reduction goal is that it provides an effective tool to guide managers in their efforts to capitalize on cost reductions (Corbett, Montes-Sancho and Kirsch, 2005; Corbett and Kirsch, 2004; Tibor and Feldman, 1995). In an EMS, specific goals are also set to determine whether the system is achieving its objectives (Melnyk et al., 2005; Melnyk, Sroufe and Calantone, 2003b; Melnyk et al., 2002). This

feedback loop is designed to allow changes to be incorporated smoothly into the organization's operations, where upper management can modify GSCM activities more efficiently and effectively. The presence of an EMS allows a firm to evaluate environmental performance against policy, objectives, and cost targets while seeking performance improvements where appropriate (Melnyk, Sroufe and Calantone, 2003a). Further, the compliance objective of an EMS should facilitate firms to obtain and maintain the minimal regulatory and legal standards for acceptable environmental impact levels (Sayre, 1996). Failure to comply can result in increased costs (fines), increased external intervention in day-to-day operations, and issuance of cease and desist orders (Melnyk, Sroufe and Calantone, 2003a). An EMS, therefore, should facilitate improved cost performance influences of GSCM by enabling increased compliance and waste reductions in the supply chain.

**H5b: The positive association between green SCM practices and cost performance is stronger in firms exhibiting higher levels of environmental management systems than in firms exhibiting lower levels of environmental management systems.**

### **3. Methods**

#### **Survey Administration and Data Collection**

A sample of 2,000 United Kingdom manufacturing firms were randomly surveyed from a commercial database held by The Manufacturer magazine. Each respondent in the sample was selected based on job function, plant size (at least 50 employees), and industry sector by SIC code. We first mailed a copy of the survey to all respondents, together with directions to the online survey. Two further email rounds were then sent to non-responders. Respondents were also offered the incentive of a composite summary of the results. We received 277 responses, of which 29 were deemed not usable due to missing data. A further 34 surveys were incorrect email or not able to be delivered. The effective response rate was thus 12.6% (248/1,966).

The characteristics of the sample organizations are shown in Table 1, including number of employees, industry sector and respondent title. The average number of years in the position was 9.32, and 15.2 years in the business unit, providing support that our informants were also knowledgeable about the issues under investigation. Respondents were asked to complete the survey in relation to their strategic business unit's supply chain.

The survey was pilot tested in two phases. The draft questionnaire was first sent to five academic experts in the area, who were asked to comment on the content, clarity and scaling of the instruments. Several minor changes were made as a result of this feedback. Second, the survey's internet address was sent to a further nine industry contacts who completed the survey on-line, with a specific focus on the content, design and usability of the instrument. Some minor design changes were made at this stage.

### **Non-Response Bias**

Tests for non-response bias were carried out by comparing early respondents (responses received within the first two weeks) and later respondents (responses received within the third week or later) (Armstrong and Overton, 1977). A *t*-test of difference was conducted on firm size (employees and sales), and mean responses to each variable. No statistically significant differences were identified.

### **Operationalization of Variables**

The survey scales used were either established scales, or developed from the literature. In the case of supply chain ecocentricity and environmental supply chain visibility we followed multistage scale development techniques for the scales (DeVellis, 2003). This process included several preliminary qualitative interviews with purchasing managers, an extensive review of the extant academic and practitioner literature, pretesting, and a Q-sort with PhD students. All constructs are reflective and measured using a seven-point Likert scale (see Appendix A).

*Operational cost performance*- Cost performance was measured using a three-item scale used by Vachon & Klassen (2008). Respondents were asked to compare their organization's total product costs, production costs and labor productivity, relative to primary competitors.

*Environmental performance* – The scale developed by Zhu et al (Zhu and Sarkis, 2007) was used to assess the degree of improvement in environmental performance over the past 1-2 years. Respondents were asked to identify metrics relating to solid waste disposal, atmospheric emissions, raw materials usage, energy usage, waste water reduction, recycling of product and solid waste.

*Green supply chain management* – The scale developed by Gonzales-Benito & Gonzalez-Benito (2006) was used to identify the extent of green supply chain management practices. Respondents were asked to consider the extent to which their firm's logistics practices, packaging, logistics-related waste recycling, sourcing strategies and supplier selection criteria considered the natural environment.

*Environmental supply chain visibility* – Environmental supply chain visibility is a new scale, developed for this study, but based on the literature on inventory tracking and supply chain transparency (Pagell and Wu, 2009). Items assessed the extent to which the firm, for its complete supply chain, traces the origins of purchases, knows the source of raw materials, knows the chemicals and elements in purchased components, tracks the processes involved in producing product, and tracks the environmental performance.

*Supply chain ecocentricity* – Supply chain ecocentricity is a new scale developed for this study, but based on supply chain tactics identified by Pagell and Wu (2009) as well as insights from Seuring (2004) and Gladwin, Kennelly, and Krause (1995). Respondents were asked about the involvement of external stakeholders (excluding

suppliers and customers) in improving their supply chain environmental sustainability, and included three-items assessing the degree of external feedback sought, partnerships with NGOs or NFPs, and input from regulators.

*Environmental management systems* – Environmental management systems is derived from the scale originally developed by McKeiver and Gadenne (McKeiver and Gadenne, 2005). Items asked about the extent to which employees are evaluated and rewarded on environmental performance, and the degree of alignment between environmental strategy, performance measures and commodity purchasing strategies.

*Internal environmental orientation* – Internal environmental orientation was operationalized as a six-item scale, developed by Fraj-Andres (2008). Respondents were asked to consider their business unit's attitudes, reflecting the relevance, awareness, priority and values placed on the natural environment.

*External environmental orientation* – External environmental orientation was operationalized as a five-item scale, developed by Fraj-Andres (2008). Respondents were asked to consider the impact of the natural environment on their business unit's activities, financial well-being, image and survival.

*Control variables* – Five additional variables were included in the analysis. First, we controlled for industry, reflecting the different pressures and industry models within the sample. Second, organization size could influence the extent of engagement in green supply chain management practices and the ability to influence cost and environmental performance. Organization size was controlled by including the number of employees.

#### **4. Results**

Exploratory factor analysis using principal components extraction, with varimax rotation, was used to extract factors with eigenvalues greater than 1.0 (Tabachnick, 2001).

Following Harman's one-factor test, all items were analyzed together, and as no one factor accounted for most of the variance, common method variance was not considered an issue (Podsakoff et al., 2003). Results of the factor analysis are presented in Table 2 suggest a nine-factor solution arising from the 40 items entered. All factor loadings were considerably above .40 and are therefore considered practically significant (Hair et al., 2006; Hair et al., 1995). Four items (listed in Appendix) failed to load on their respective factors and were dropped from the analysis. Table 3 provides correlations and descriptive statistics.

OLS moderated hierarchical regression was used to test the various hypotheses. Control variables were entered in Step 1, followed by the three independent variables (opportunism, legal bonds and social interaction ties) in Step 2. Independent variables were mean centered prior to the multiplication of the interaction terms, which were entered in Step 3. Variance Inflation Factors (VIF) were all below 10, indicating multicollinearity was not an issue (Neter, 1996).

-----

Insert Table 2 About Here

-----

-----

Insert Table 3 About Here

-----

Table 4 presents the results of our theoretical model. Hypothesis 1 examined the effects of internal and external environmental orientation on the level of green supply chain management. We found support for Hypothesis 1, with significant direct effects identified for both internal ( $\beta=.41$ ,  $p<.001$ ) and external environmental orientation ( $\beta=.15$ ,  $p<.01$ ) on the level of green supply chain management. Hypothesis 2 was supported with green supply

chain management positively related to both environmental ( $\beta=.24$ ,  $p<.001$ ) and cost performance ( $\beta=.20$ ,  $p<.05$ ).

-----  
Insert Table 4 About Here  
-----

We find partial support for Hypothesis 3 (Mod 2b) Supply chain ecocentricity positively moderates the relationship between green supply chain management and cost performance ( $\beta=.24$ ,  $p<.001$ ) (H3a), but no significant interaction was present for environmental performance (H3b). Hypothesis 4 proposed a positive moderating effect for environmental supply chain visibility. Results (Mod 2a) indicate that supply chain visibility positively moderates the relationship between GSCM and cost performance ( $\beta=.18$ ,  $p<.05$ ) (H4a), though contrary to expectations, a significant and negative interaction effect was identified for environmental performance ( $\beta=-.11$ ,  $p<.05$ ) (H4b). Finally, environmental management systems was shown to have a positive moderating effect on the relationship between GSCM and cost performance ( $\beta=.16$ ,  $p<.01$ ) (H5a), but not environmental performance (H5b).

To further probe the moderated effects, we plot the simple slope for the relationship between GSCM and environmental or cost performance at high and low levels of each moderator. High and low values are defined as plus and minus one standard deviation from the mean {Cohen, 1983 #1511}. Figures 2–5 illustrate these effects.

-----  
Insert Figure 2 About Here  
-----  
-----

-----  
Insert Figure 3 About Here

-----  
-----  
Insert Figure 4 About Here  
-----  
-----

-----  
-----  
Insert Figure 5 About Here  
-----  
-----

## **5. Implications & Future Research**

The findings support theory that important antecedents to GSCM are internal and external environmental orientation and the GSCM improves firm costs and environmental performance. The findings also provide evidence for the importance of complimentary capabilities in facilitating the effectiveness of GSCM in improving firm costs. These findings provide managerial and theoretical insights to our overall understanding of the nature of the firm orientation, GSCM, and environmental and cost performance.

The support for the GSCM-performance link adds to the growing empirical evidence that suggests a positive relationship between GSCM and financial and environmental performance (e.g., Montabon, Sroufe and Narasimhan, 2007; Rao and Holt, 2005; Carter, Kale and Grimm, 2000). In particular, our results suggest that GSCM is positively related to with environmental performance ( $\beta=.24, p<.001$ ). This is an important additional step in understanding GSCM, since support for this relationship has generally been assumed in previous research but with little empirical confirmation.

Our results also advance understanding of the GSCM- performance relationship. Research investigating this relationship has suggested that the link is complicated and that future research should explore moderating factors that could explain this link more fully (e.g.,

Jacobs, Singhal and Subramanian, 2010; Zhu and Sarkis, 2004). To this end, our research included three complementary capabilities to GSCM. Our results suggest that supply chain ecocentricity, supply chain visibility, and environmental management systems were key facilitators to successful, cost performance improving GSCM practices. Interestingly, we did not find support for these as positively moderating the GSCM-environmental performance relationship. Perhaps these are enablers of waste reductions that remove inefficiencies of the GSCM practices immediately, but their effects on environmental performance are longer-term. Future research should explore reasons for this counter-intuitive results.

Our research design was survey based and cross-sectional, therefore, future research should investigate the constructs in our model using time series data. This is especially important given that it could be argued that many GSCM initiatives take longer periods of time to influence environmental performance. Future studies would benefit from longitudinal designs that permit stronger direct testing of causality and examination of potential feedback loops among variables. In addition, future research should seek to generalize these results beyond United Kingdom manufacturing firms from the commercial database held by The Manufacturer magazine by testing our model with additional samples in other contexts (e.g., cultures, locations, and supply chain entities).

The cost performance measures were assessed using subjective scales, since it provided a larger available sample size than if objective measures were requested. Past research has found that managerial assessments are consistent with objective internal performance (Slater and Narver, 1994; Pearce, Robbins and Robinson, 1987; Dess and Robinson, 1984) and with external secondary data (Venkatraman and Ramanujam, 1986). However, future research would benefit from capturing secondary data if available. Further, the limitations of survey design did not allow for the capture of potentially important control variables. This is especially important in controlling for other important financial

performance variables since, for example, market share, return on sales, assets, and investments, are valuable firm factors to assess. Future research should explore these relationships.

## 5. References

- Adams, R. B., Licht, A. N., and Sagiv, L. (2011), "Shareholders and Stakeholders: How Do Directors Decide?" *Strategic Management Journal*, Vol. 32, No. 12, pp. 1331-1355.
- Armstrong, S. J., and Overton, T. S. (1977), "Estimating Non-Response Bias in Mail Surveys" *Journal of Marketing Research*, Vol. XIV, No. August, pp. 396-402.
- Baker, W. E., and Sinkula, J. M. (2005), "Market Orientation and the New Product Paradox" *The Journal of Product Innovation Management*, Vol. 22, No. 6, pp. 483-475.
- Banerjee, S. B. (2002), "Corporate Environmentalism the Construct and Its Measurement" *Journal of Business Research*, Vol. 55, No. 3, pp. 177-191.
- Banerjee, S. B. (2011), "Embedding Sustainability across the Organization: A Critical Perspective" *Academy of Management Learning & Education*, Vol. 10, No. 4, pp. 719-731.
- Banerjee, S. B., Iyer, E. S., and Kashyap, R. K. (2003), "Corporate Environmentalism: Antecedents and Influence of Industry Type" *Journal of Marketing*, Vol. 67, No. 2, pp. 106-122.
- Bansal, P., and Clelland, I. (2004), "Talking Trash: Legitimacy, Impression Management, and Unsystematic Risk in the Context of the Natural Environment" *Academy of Management Journal*, Vol. 47, No. 1, pp. 93-103.
- Barney, J. B. (2001), "Is the Resource-Based "View" a Useful Perspective for Strategic Management Research? Yes" *Academy of Management Review*, Vol. 26, No. 1, pp. 41-56.
- Brown, D. L., Dillard, J. F., and Marshall, R. S. (2005), "Strategically Informed, Environmentally Conscious Information Requirements for Accounting Information Systems" *Journal of Information Systems*, Vol. 19, No. 2, pp. 79-103.
- Buysse, K., and Verbeke, A. (2003), "Proactive Environmental Strategies: A Stakeholder Management Perspective" *Strategic Management Journal*, Vol. 24, No. 5, pp. 453.
- Byrne, M. R., and Polonsky, M. J. (2001), "Impediments to Consumer Adoption of Sustainable Transportation: Alternative Fuel Vehicles" *International Journal of Operations & Production Management*, Vol. 21, No. 12, pp. 1521.
- Carter, C. R., Kale, R., and Grimm, C. M. (2000), "Environmental Purchasing and Firm Performance: An Empirical Investigation" *Transportation Research: Part E*, Vol. 36, No. 3, pp. 219.
- Christmann, P. (2000), "Effects of "Best Practices" of Environmental Management on Cost Advantage: The Role of Complementary Assets" *Academy of Management Journal*, Vol. 43, No. 4, pp. 663-680.
- Corbett, C. J., and Kirsch, D. A. (2004), "Response to "Revisiting Iso 14000 Diffusion: A New "Look" at the Drivers of Certification"" *Production & Operations Management*, Vol. 13, No. 3, pp. 268-271.

Corbett, C. J., Montes-Sancho, M. J., and Kirsch, D. A. (2005), "The Financial Impact of Iso 9000 Certification in the United States: An Empirical Analysis" *Management Science*, Vol. 51, No. 7, pp. 1046-1059.

Cruz, J. M., and Matsypura, D. (2009), "Supply Chain Networks with Corporate Social Responsibility through Integrated Environmental Decision-Making" *International Journal of Production Research*, Vol. 47, No. 3, pp. 621-648.

Dacin, M. T., Oliver, C., and Roy, J.-P. (2007), "The Legitimacy of Strategic Alliances: An Institutional Perspective" *Strategic Management Journal*, Vol. 28, No. 2, pp. 169-187.

Deshpande, R., and Webster, F. E., Jr. (1989), "Organizational Culture and Marketing: Defining the Research Agenda" *Journal of Marketing*, Vol. 53, No. 1, pp. 3-15.

Dess, G. G., and Robinson, R. B., Jr. (1984), "Measuring Organizational Performance in the Absence of Objective Measures: The Case of the Privately-Held Firm and Conglomerate Business Unit" *Strategic Management Journal*, Vol. 5, No. 3, pp. 265-273.

DeVellis, R. F. (2003). *Scale Development: Theory and Applications (2nd ed.)*. Newbury Park, CA: Sage Publications.

DiMaggio, P. J., and Powell, W. W. (1983), "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields" *American Sociological Review*, Vol. 48, No. 2, pp. 147-160.

Eesley, C., and Lenox, M. J. (2006), "Firm Responses to Secondary Stakeholder Action" *Strategic Management Journal*, Vol. 27, No. 8, pp. 765-781.

Ellram, L. M., Zsidisin, G. A., Siferd, S. P., and Stanly, M. J. (2002), "The Impact of Purchasing and Supply Management Activities on Corporate Success" *Journal of Supply Chain Management*, Vol. 38, No. 1, pp. 4-17.

Faucheux, S., and Nicolai, I. (2011), "It for Green and Green It: A Proposed Typology of Eco-Innovation" *Ecological Economics*, Vol. 70, No. 11, pp. 2020-2027.

Foerstl, K., Reuter, C., Hartmann, E., and Blome, C. (2010), "Managing Supplier Sustainability Risks in a Dynamically Changing Environment—Sustainable Supplier Management in the Chemical Industry" *Journal of Purchasing & Supply Management*, Vol. 16, No. 2, pp. 118-130.

Fraj-Andrés, E., Martínez-Salinas, E., and Matute-Vallejo, J. (2009), "A Multidimensional Approach to the Influence of Environmental Marketing and Orientation on the Firm's Organizational Performance" *Journal of Business Ethics*, Vol. 88, No. 2, pp. 263-286.

Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*: Pittman, Marshall.

Gladwin, T. N., Kennelly, J. J., and Krause, T.-S. (1995), "Shifting Paradigms for Sustainable Development: Implications for Management Theory and Research" *Academy of Management Review*, Vol. 20, No. 4, pp. 874-907.

González-Benito, J., and González-Benito, Ó. (2006), "The Role of Stakeholder Pressure and Managerial Values in the Implementation of Environmental Logistics Practices" *International Journal of Production Research*, Vol. 44, No. 7, pp. 1353-1373.

González-Torre, P. L., Adenso-Díaz, B., and Artiba, H. (2004), "Environmental and Reverse Logistics Policies in European Bottling and Packaging Firms" *International Journal of Production Economics*, Vol. 88, No. 1, pp. 95.

Haigh, N., and Griffiths, A. (2008), "The Environmental Sustainability of Information Systems: Considering the Impact of Operational Strategies and Practices" *International Journal of Technology Management*, Vol. 43, No. 1-3, pp. 48-63.

Hair, J. F., Anderson, R. E., Tatham, R. L., and Black, W. C. (1995). *Multivariate Data Analysis with Readings*. Englewood Cliffs, NJ: Prentice-Hall.

Hair, J. F., Black, W. C., Anderson, R. E., and Tatham, R. L. (2006). *Multivariate Data Analysis (6 ed.)*. Upper Saddle River, NJ: Pearson Prentice Hall.

Handfield, R., Walton, S. V., Sroufe, R., and Melnyk, S. A. (2002), "Applying Environmental Criteria to Supplier Assessment: A Study in the Application of the Analytical Hierarchy Process" *European Journal of Operational Research*, Vol. 141, No. 1, pp. 70-87.

Hart, S. L. (1995), "A Natural-Resource-Based View of the Firm" *Academy of Management Review*, Vol. 20, No. 4, pp. 986-1014.

Jacobs, B. W., Singhal, V. R., and Subramanian, R. (2010), "An Empirical Investigation of Environmental Performance and the Market Value of the Firm" *Journal of Operations Management*, Vol. 28, No. 5, pp. 430-441.

Jayaraman, V., Klassen, R., and Linton, J. D. (2007). Supply Chain Management in a Sustainable Environment. *Journal of Operations Management*, 1071-1074.

Jayaraman, V., Linton, J., and Klassen, R. (2005), "A Supply Chain Management in a Sustainable Environment" *Journal of Operations Management*, Vol. 23, No. 1, pp. 103-104.

Jenkin, T. A., McShane, L., and Webster, J. (2011), "Green Information Technologies and Systems: Employees' Perceptions of Organizational Practices" *Business & Society*, Vol. 50, No. 2, pp. 266-314.

Jiang, R. J., and Bansal, P. (2003), "Seeing the Need for Iso 14001" *Journal of Management Studies*, Vol. 40, No. 4, pp. 1047-1067.

King, A. A., Lenox, M. J., and Terlaak, A. N. N. (2005), "The Strategic Use of Decentralized Institutions: Exploring Certification with the Iso 14001 Management Standard" *Academy of Management Journal*, Vol. 48, No. 6, pp. 1091-1106.

Linton, J. D., Klassen, R., and Jayaraman, V. (2007), "Sustainable Supply Chains: An Introduction" *Journal of Operations Management*, Vol. 25, No. 6, pp. 1075-1082.

Matos, S., and Hall, J. (2007). Integrating Sustainable Development in the Supply Chain: The Case of Life Cycle Assessment in Oil and Gas and Agricultural Biotechnology. *Journal of Operations Management*, 1083-1102.

- McKeiver, C., and Gadenne, D. (2005), "Environmental Management Systems in Small and Medium Businesses" *International Small Business Journal*, Vol. 23, No. 5, pp. 513-537.
- Melnyk, S. A., Sroufe, R. P., and Calantone, R. (2003a). Assessing the Impact of Environmental Management Systems on Corporate and Environmental Performance. *Journal of Operations Management*, 329.
- Melnyk, S. A., Sroufe, R. P., and Calantone, R. J. (2003b), "A Model of Site-Specific Antecedents of Iso 14001 Certification" *Production & Operations Management*, Vol. 12, No. 3, pp. 369-385.
- Melnyk, S. A., Sroufe, R. P., Calantone, R. J., and Montabon, F. (2005), "Erratum: A Model of Site-Specific Antecedents of Iso 14001 Certification" *Production & Operations Management*, Vol. 14, No. 4, pp. 514-514.
- Melnyk, S. A., Sroufe, R. P., Calantone, R. L., and Montabon, F. L. (2002), "Assessing the Effectiveness of Us Voluntary Environmental Programmes: An Empirical Study" *International Journal of Production Research*, Vol. 40, No. 8, pp. 1853-1878.
- Min, H., and Galle, W. P. (2001), "Green Purchasing Practices of Us Firms" *International Journal of Operations & Production Management*, Vol. 21, No. 9/10, pp. 1222.
- Montabon, F., Melnyk, S. A., Sroufe, R., and Calantone, R. J. (2000), "Iso 14000: Assessing Its Perceived Impact on Corporate Performance" *Journal of Supply Chain Management*, Vol. 36, No. 2, pp. 4-16.
- Montabon, F., Sroufe, R., and Narasimhan, R. (2007), "An Examination of Corporate Reporting, Environmental Management Practices and Firm Performance" *Journal of Operations Management*, Vol. 25, No. 5, pp. 998-1014.
- Murphy, P. R., Poist, R. F., and Braunschweig, C. D. (1996), "Green Logistics: Comparative Views of Environmental Progressives, Moderates, and Conservatives" *Journal of Business Logistics*, Vol. 17, No. 1, pp. 191-211.
- Pagell, M., and Wu, Z. (2009), "Building a More Complete Theory of Sustainable Supply Chain Management Using Case Studies of 10 Exemplars" *Journal of Supply Chain Management*, Vol. 45, No. 2, pp. 37-56.
- Pearce, J. A., II, Robbins, D. K., and Robinson, R. B., Jr. (1987), "The Impact of Grand Strategy and Planning Formality on Financial Performance" *Strategic Management Journal*, Vol. 8, No. 2, pp. 125-134.
- Podsakoff, P. M., MacKenzi, S. B., Lee, J. Y., and Podsakoff, N. P. (2003), "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies" *Journal of Applied Psychology Bulletin*, Vol. 88, No. 5, pp. 879-903.
- Pullman, M. E., Maloni, M. J., and Carter, C. R. (2009), "Food for Thought: Social Versus Environmental Sustainability Practices and Performance Outcomes" *Journal of Supply Chain Management*, Vol. 45, No. 4, pp. 38-54.

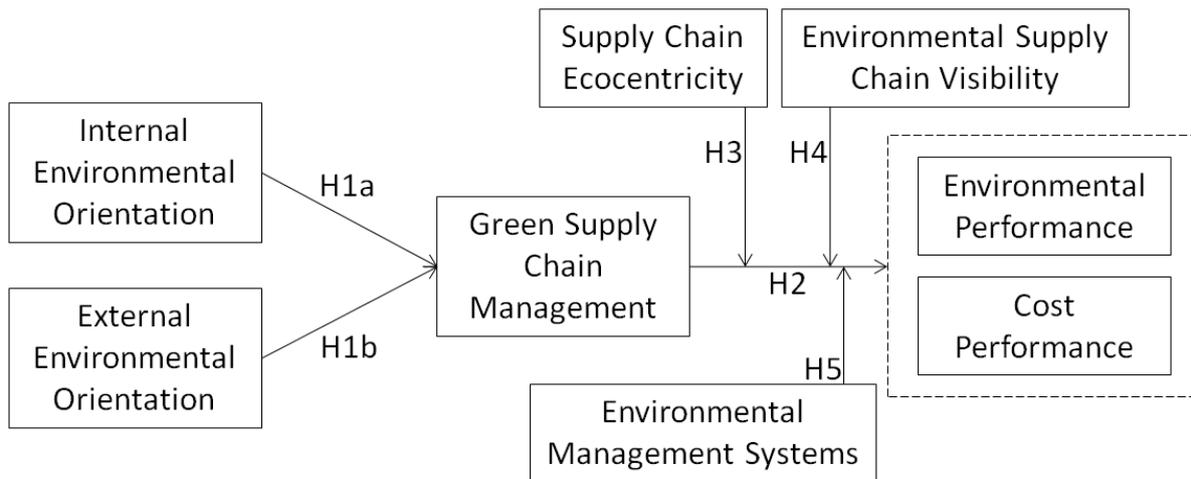
- Ramchander, S., Schwebach, R. G., and Staking, K. I. M. (2012), "The Informational Relevance of Corporate Social Responsibility: Evidence from Ds400 Index Reconstitutions" *Strategic Management Journal*, Vol. 33, No. 3, pp. 303-314.
- Rao, P., and Holt, D. (2005), "Do Green Supply Chains Lead to Competitiveness and Economic Performance?" *International Journal of Operations & Production Management*, Vol. 25, No. 9, pp. 898-916.
- Reuter, C., Foerstl, K. A. I., Hartmann, E. V. I., and Blome, C. (2010), "Sustainable Global Supplier Management: The Role of Dynamic Capabilities in Achieving Competitive Advantage" *Journal of Supply Chain Management*, Vol. 46, No. 2, pp. 45-63.
- Rivera-Camino, J. (2007), "Re-Evaluating Green Marketing Strategy: A Stakeholder Perspective" *European Journal of Marketing*, Vol. 41, No. 11/12, pp. 1328-1358.
- Rogers, D. S., and Tibben-Lembke, R. (2001), "An Examination of Reverse Logistics Practices" *Journal of Business Logistics*, Vol. 22, No. 2, pp. 129-148.
- Russo, M. V., and Fouts, P. A. (1997), "A Resource-Based Perspective on Corporate Environmental Performance and Profitability" *Academy of Management Journal*, Vol. 40, No. 3, pp. 534-559.
- Sarkis, J., Gonzalez-Torre, P., and Adenso-Diaz, B. (2010), "Stakeholder Pressure and the Adoption of Environmental Practices: The Mediating Effect of Training" *Journal of Operations Management*, Vol. 28, No. 2, pp. 163-176.
- Sarkis, J., Zhu, Q., and Lai, K.-h. (2011), "An Organizational Theoretic Review of Green Supply Chain Management Literature" *International Journal of Production Economics*, Vol. 130, No. 1, pp. 1-15.
- Setterstrom, A. (2008). The Natural Resource-Base View of a Firm: Strategic Opportunities in It. *Annual Academy of Management Meetings*. Anaheim, CA.
- Seuring, S. (2004), "Integrated Chain Management and Supply Chain Management Comparative Analysis and Illustrative Cases" *Journal of Cleaner Production*, Vol. 12, No. 8-10, pp. 1059-1071.
- Shrivastava, P. (1995a), "Environmental Technologies and Competitive Advantage" *Strategic Management Journal*, Vol. 16, No. (Special Issue), pp. 183-200.
- Shrivastava, P. (1995b), "The Role of Corporations in Achieving Ecological Sustainability" *Academy of Management Review*, Vol. 20, No. 4, pp. 936-960.
- Slater, S. F., and Narver, J. C. (1994), "Does Competitive Environment Moderate the Market Orientation-Performance Relationship?" *Journal of Marketing*, Vol. 58, No. 1, pp. 46-55.
- Sroufe, R. (2003), "Effects of Environmental Management Systems on Environmental Management Practices and Operations" *Production & Operations Management*, Vol. 12, No. 3, pp. 416-431.

- Stone, G. W., and Wakefield, K. L. (2000), "Eco-Oriented: An Extension of Market Orientation in an Environmental Context" *Journal of Marketing Theory & Practice*, Vol. 8, No. 3, pp. 21.
- Suchman, M. C. (1995), "Managing Legitimacy: Strategic and Institutional Approaches" *Academy of Management Review*, Vol. 20, No. 3, pp. 571-610.
- Tabachnick, B. G., Fidell, L.S. (2001). *Using Multivariate Statistics (4th ed.)*. Needham Heights, MA: Allyn and Bacon
- Tate, W. L., Dooley, K. J., and Ellram, L. M. (2011), "Transaction Cost and Institutional Drivers of Supplier Adoption of Environmental Practices" *Journal of Business Logistics*, Vol. 32, No. 1, pp. 6-16.
- Tibor, T., and Feldman, I. (1995), "Who Will Accredite Iso 14000 Registrars?" *Chemical Week*, Vol. 157, No. 17, pp. 50.
- Vachon, S., and Klassen, R. D. (2008), "Environmental Management and Manufacturing Performance: The Role of Collaboration in the Supply Chain" *International Journal of Production Economics*, Vol. 111, No. 2, pp. 299-315.
- Van Huijstee, M., and Glasbergen, P. (2010), "Business–Ngo Interactions in a Multi-Stakeholder Context" *Business & Society Review (00453609)*, Vol. 115, No. 3, pp. 249-284.
- Venkatraman, N., and Ramanujam, V. (1986), "Measurement of Business Performance in Strategy Research: A Comparison of Approaches" *Academy of Management Review*, Vol. 11, No. 4, pp. 801-814.
- Visseren-Hamakers, I. J., Arts, B., and Glasbergen, P. (2011), "Interaction Management by Partnerships: The Case of Biodiversity and Climate Change" *Global Environmental Politics*, Vol. 11, No. 4, pp. 89-107.
- Wang, L., Yeung, J. H. Y., and Zhang, M. (2011), "The Impact of Trust and Contract on Innovation Performance: The Moderating Role of Environmental Uncertainty" *International Journal of Production Economics*, Vol. 134, No. 1, pp. 114-122.
- Watson, R. T., Boudreau, M.-C., and Chen, A. J. (2010), "Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community" *MIS Quarterly*, Vol. 34, No. 1, pp. 23-38.
- Wu, H.-J., and Dunn, S. C. (1995), "Environmentally Responsible Logistics Systems" *International Journal of Physical Distribution & Logistics Management*, Vol. 25, No. 2, pp. 20.
- Wu, Z., and Pagell, M. (2011), "Balancing Priorities: Decision-Making in Sustainable Supply Chain Management" *Journal of Operations Management*, Vol. 29, No. 6, pp. 577-590.
- Zhu, Q., and Sarkis, J. (2004), "Relationships between Operational Practices and Performance among Early Adopters of Green Supply Chain Management Practices in Chinese Manufacturing Enterprises" *Journal of Operations Management*, Vol. 22, No. 3, pp. 265-289.

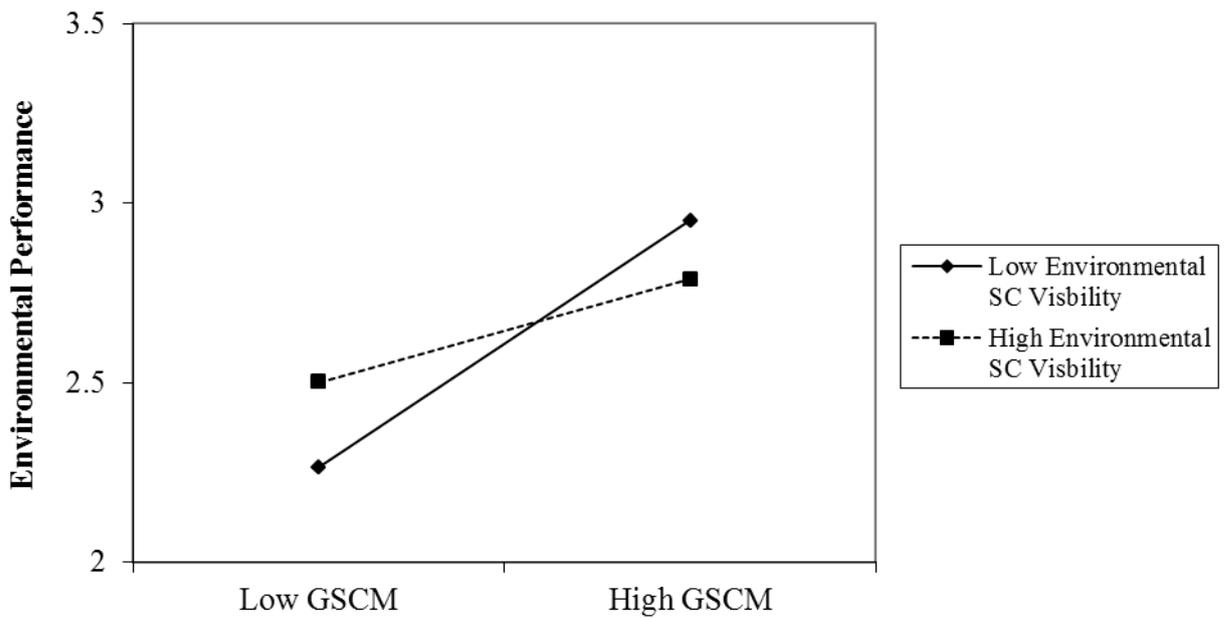
Zhu, Q., and Sarkis, J. (2007), "The Moderating Effects of Institutional Pressures on Emergent Green Supply Chain Practices and Performance" *International Journal of Production Research*, Vol. 45, No. 18/19, pp. 4333-4355.

Zhu, Q., Sarkis, J., Cordeiro, J. J., and Lai, K.-H. (2008), "Firm-Level Correlates of Emergent Green Supply Chain Management Practices in the Chinese Context" *Omega*, Vol. 36, No. 4, pp. 577-591.

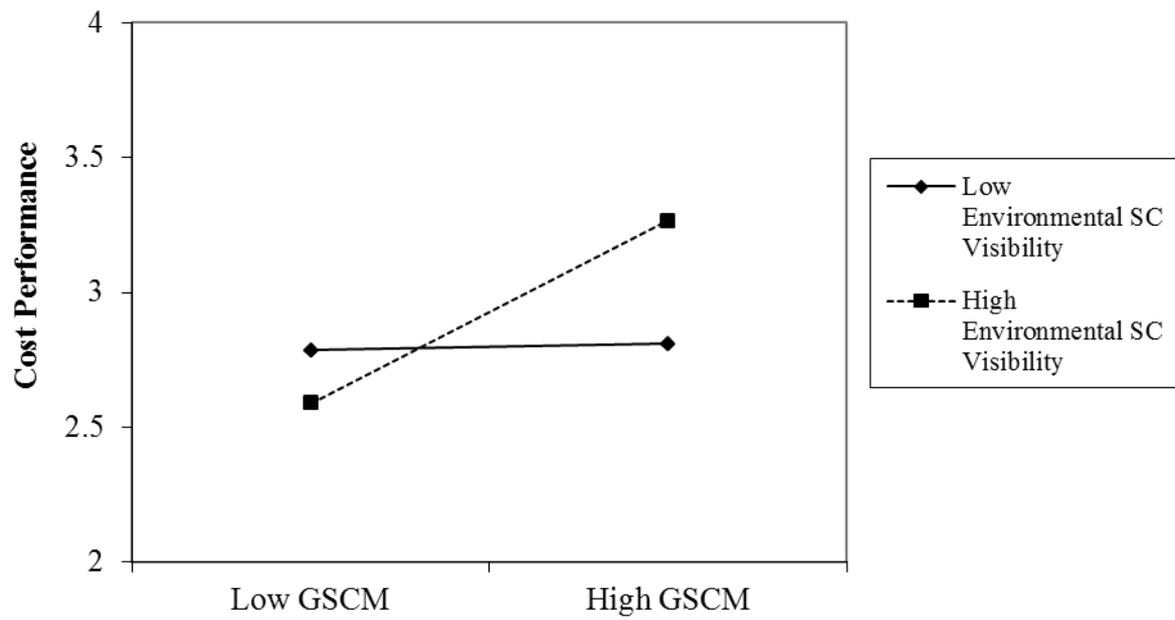
**Figure 1: Theoretical Framework**



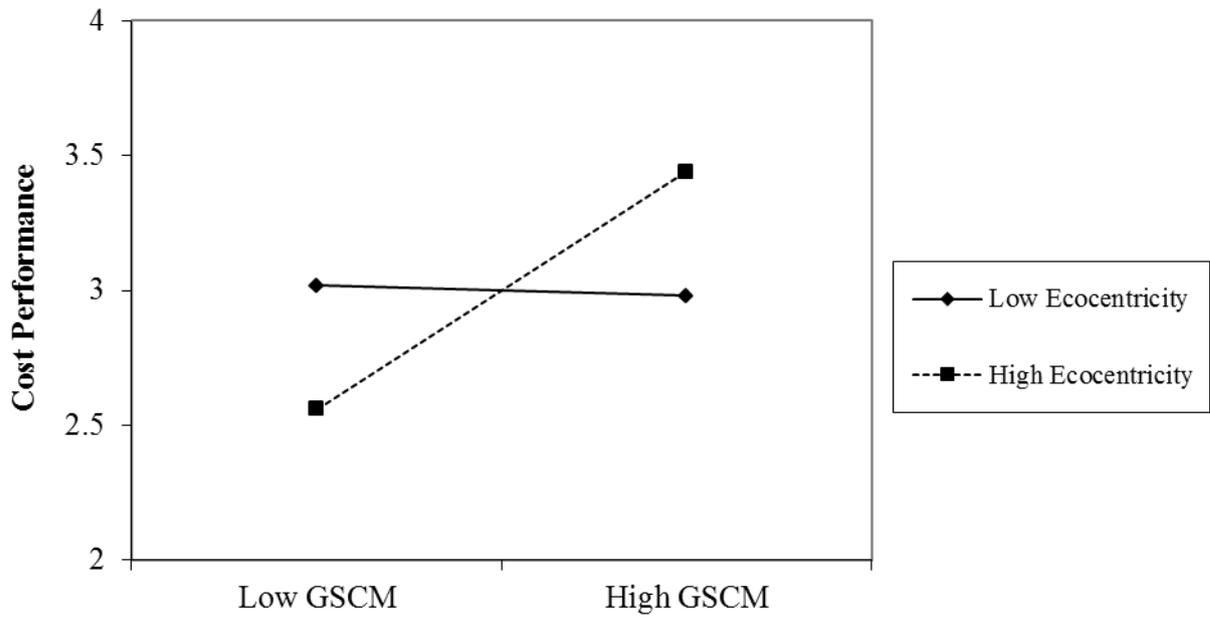
**Figure 2: Moderation of GSCM and Environmental SC Visibility on Environmental Performance**



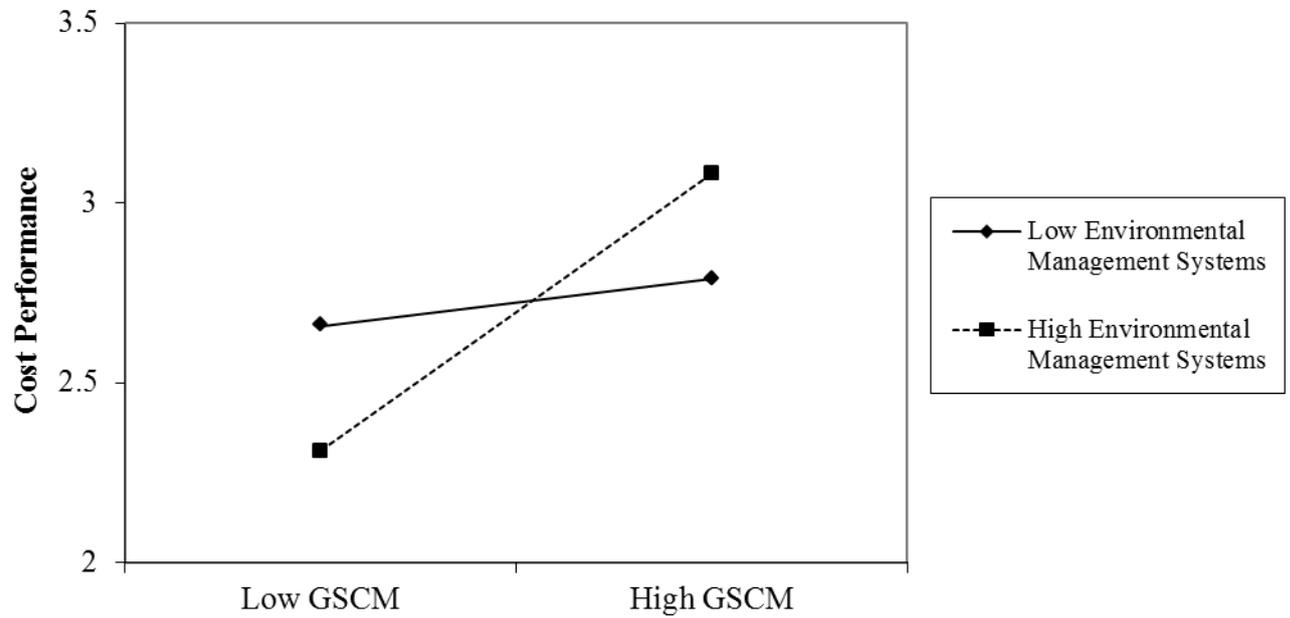
**Figure 3:** Moderation of GSCM and Environmental SC Visibility on Cost Performance



**Figure 4:** Moderation of GSCM and SC Ecocentricity on Cost Performance



**Figure 4:** Moderation of GSCM and Environmental Management Systems on Cost Performance



**Table 1:** Sample Characteristics

<b>Industry</b>	<b>Number</b>	<b>Percentage</b>
Machinery & Equipment	45	18.3
Packaging	24	9.8
Furniture	20	8.1
Automotive	27	11.0
Aerospace	15	6.1
Fabricated Metal Products	33	13.4
Computer & Electronics	27	11.0
Chemical & Plastics	31	12.6
Food	7	2.8
Missing	19	7.8
Total	248	100

<b>Position</b>	<b>Number</b>	<b>Percentage</b>
Director of Purchasing/Head of Supply Chain	30	12.1
Head of Operations	10	4.0
Purchasing/Supply Chain Manager	80	32.3
Senior Buyer / Buyer	23	9.3
Materials/Logistics Manager	46	18.5
Operations/Quality Manager	33	13.3
Environmental Manager	13	5.2
Missing	13	5.2
Total	248	100

<b>Organization Size (employees)</b>	<b>Number</b>	<b>Percentage</b>
50 - 99	68	27.4
100 -149	32	12.9
150 - 199	18	7.3
200 - 499	76	30.6
500 - 999	21	8.5
Over 1000	25	10.1
Missing	8	3.2
Total	248	100

**Table 2: Exploratory Factor Analysis**

Internal Environmental Orientation

At our firm, we make a concerted effort to make every employee understand the importance of environmental preservation	.86
Environmental preservation is a high priority activity in our firm	.84
Our firm has a clear policy statement urging environmental awareness in every area of operations	.82
We try to promote environmental preservation as a major goal across all departments	.82
Preserving the environment is a central corporate value in our firm	.80
Environmental issues are very relevant to the major function of our firm	.72

Environmental Performance

Diverted solid waste from landfills	.74
Reduced raw materials usage	.73
Recycling of solid waste (not incineration)	.72
Reduced solid waste disposal	.70
Reduced emissions into the atmosphere	.69
Reduced waste water usage	.64
Reduced energy usage	.62
Decrease use of hazardous/harmful/toxic materials	.58

Green Supply Chain Management

... ecological materials for primary packaging	.78
... recyclable or reusable packaging/containers in logistics	.75
... selection of cleaner transportation methods	.71
... a preference for green products in purchasing	.70
... recuperation and recycling systems	.61
... environmental criteria in supplier selection	.60
... consolidation of shipments	.55

Environmental Supply Chain Visibility

We know the sources of our raw materials	.86
We track the processes involved in producing product throughout our complete supply chain	.83
We trace the origins of our purchases through the entire supply chain	.83
We track the environmental performance of our complete supply chain	.74
We know what chemicals or elements are in our purchased components	.64

Cost Performance

Total product costs	.91
Production costs	.90
Labour productivity	.84

Internal Environmental Orientation

The financial well being of our firm depends on the state of the natural environment	.86
--	-----

The natural environment affects our firm's business activity	.79
Environmental preservation is vital to our firm's survival	.75
<i><u>Environmental Management Systems</u></i>	
Employee reward systems are linked to achieving environmental outcomes	.82
Employees within our firm are evaluated on environmental performance	.70
Environmental performance measures are aligned with our corporate environmental strategy	.50
<i><u>Supply Chain Ecocentricity</u></i>	
We incorporate external feedback (e.g. from trade associations) to help improve the sustainability of our supply chain	.77
We partner with NGO's and not-for-profit organisations to learn about potential solutions to environmental problems	.74
We incorporate input from regulators (e.g. UK Environment Agency, DEFRA) into our supply chain policy and practices	.51

---

**Table 3:** Descriptive Statistics

Variable <sup>a</sup>	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Operating cost improvement	<b>.89</b>													
2 Environment performance improvement	.26	<b>.88</b>												
3 Environmental supply chain management	.30	.54	<b>.90</b>											
4 Internal environmental orientation	.22	.53	.52	<b>.95</b>										
5 External environmental orientation	.10	.33	.37	.51	<b>.86</b>									
6 Supply chain ecocentricity	.16	.52	.58	.55	.42	<b>.78</b>								
7 Environmental supply chain visibility	.20	.32	.53	.35	.35	.42	<b>.89</b>							
8 Environmental management systems	.19	.50	.60	.65	.45	.58	0.47	<b>.84</b>						
9 Industry - machinery/equipment	.00	-.18	-.05	-.15	-.08	-.16	.01	-.15	-					
10 Industry - automotive/aerospace	.00	-.02	-.03	.10	-.01	-.03	.05	.09	-.21	-				
11 Industry - fabricated metal	-.02	-.03	-.11	-.08	-.03	-.04	-.19	-.10	-.18	-.18	-			
12 Industry - chemical / plastics	.01	.06	.04	-.01	.02	.06	-.04	.01	-.16	-.16	-.14	-		
13 Industry - computer hardware / electronics	-.06	.11	.02	.13	.08	.16	.11	.17	-.18	-.17	-.15	-.13	-	
14 Organization size (employees)	.12	.01	.09	.11	.08	.08	.07	.11	-.07	.01	-.05	-.05	.01	-
Mean	4.61	5.11	4.52	5.16	4.13	4.24	4.32	3.66	.18	.17	.13	.11	.13	785.90
Standard Deviation	1.04	1.04	1.29	1.35	1.40	1.36	1.51	1.44	.39	.38	.34	.31	.33	3510.13

<sup>a</sup> Significant at .05 (two-tailed) when  $r > .125$

n=248

**Table 4:** Results of Multiple Regression Analysis <sup>a, b</sup>

Variables	Green Logistics		Cost Performance				Environmental Performance				
	Mod 1	Mod 2	Mod 1	Mod 2a	Mod 2b	Mod 2c	Mod 1	Mod 2a	Mod 2b	Mod 2c	
<i>Block 1: Controls</i>											
Industry – machinery/equipment	-.05	-.01	-.03	-.04	-.03	-.02	-.11 <sup>†</sup>	-.12 <sup>†</sup>	-.12 <sup>†</sup>	-.13 <sup>†</sup>	
Industry – automotive/aerospace	-.10	-.12 <sup>†</sup>	-.09	-.09	-.07	-.06	-.08	-.08	-.07	-.10	
Industry – fabricated metal	-.08	-.06	-.03	-.04	-.06	-.05	.00	.02	.00	.01	
Industry – chemical/plastics	.01	.01	-.03	-.05	-.04	-.04	.01	.03	.01	.02	
Industry – computer/electronics	-.03	-.08	-.14 <sup>†</sup>	-.12 <sup>†</sup>	-.11 <sup>†</sup>	-.11	.00	.01	.01	.00	
Organization size (log employee)	.10	.04	.11	.10	.11	.12 <sup>†</sup>	-.01	.01	.00	-.01	
<i>Block 2: Main effects</i>											
Internal environmental orientation		.41***	.15	.15*	.17*	.15*	.26***	.33***	.29***	.29***	
External environmental orientation		.15**	-.06	-.08	-.03	-.04	-.01	.02	.00	.00	
Green supply chain management			.20*	.22**	.26***	.28***	.24***	.30***	.27***	.26***	
Environmental supply chain visibility			.10	.09			.00	.03			
Supply chain ecocentricity			-.04		.00		.16*		.17**		
Environmental management systems			-.01			-.02	.10 <sup>†</sup>			.14	
<i>Block 3: Two-way interactions</i>											
Green supply chain management x Environmental supply chain visibility				.18**				-.11*			
Green supply chain management x Supply chain ecocentricity					.24***				.01		
Green supply chain management x Environmental management systems						.16**				-.06	
	$\Delta R^2$ <sup>b</sup>	.13	.22	.10	.03	.05	.02	.35	.01	.00	.00
	<i>F for</i> $\Delta R^2$ <sup>b</sup>	4.99	39.10	4.14	8.13	13.59	6.27	22.63	4.17	.03	1.06
	$R^2$	.11	.33	.13	.12	.14	.11	.38	.37	.38	.37
	<i>F</i>	4.99	13.84	2.88	3.99	4.41	3.63	13.13	13.81	14.11	13.80

<sup>a</sup> Standardized regression coefficients are shown<sup>b</sup> Changes in  $R^2$  are from the penultimate block within the same model<sup>†</sup>  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

## **APPENDIX. Constructs and Items**

### **Cost Performance**

- a. Production costs
- b. Total product costs
- c. Labor productivity

### **Environmental Performance**

- a. Reduced solid waste disposal
- b. Reduced emissions into the atmosphere
- c. Reduced raw materials usage
- d. Reduced energy usage
- e. Diverted solid waste from landfills
- f. Reduced waste water usage
- g. Decrease use of hazardous/harmful/toxic materials
- h. Recycling of solid waste (not incineration)

### **Internal Environmental Orientation**

- a. Environmental issues are very relevant to the major function of our firm
- b. At our firm, we make a concerted effort to make every employee understand the importance of environmental preservation
- c. We try to promote environmental preservation as a major goal across all departments
- d. Our firm has a clear policy statement urging environmental awareness in every area of operations
- e. Environmental preservation is a high priority activity in our firm
- f. Preserving the environment is a central corporate value in our firm

### **External Environmental Orientation**

- a. The natural environment affects our firm's business activity
- b. The financial well-being of our firm depends on the state of the natural environment
- c. Environmental preservation is vital to our firm's survival
- d. Our firm strives for an image of environmental responsibility \*\*
- e. In our firm, environmental preservation is largely an issue of maintaining a good public image \*

### **Green supply chain management**

- a. ...a preference for green products in purchasing
- b. ... environmental criteria in supplier selection
- c. ... consolidation of shipments
- d. ... selection of cleaner transportation methods
- e. ... recyclable or reusable packaging/containers in logistics
- f. ... ecological materials for primary packaging
- g. ... recuperation and recycling systems
- h. ... responsible disposal of waste and residues (separation and preparation) \*

**Supply chain ecocentricity**

- a. We incorporate external feedback (e.g. from trade associations) to help improve the sustainability of our supply chain
- b. We partner with NGO's and not-for-profit organisations to learn about potential solutions to environmental problems
- c. We incorporate input from regulators (e.g. UK Environment Agency, DEFRA) into our supply chain policy and practices
- d. We actively engage external parties (e.g. customers, suppliers) in seeking to improve environmental performance \*

**Environmental supply chain visibility**

- a. We trace the origins of our purchases through the entire supply chain
- b. We know the sources of our raw materials
- c. We track the processes involved in producing product throughout our complete supply chain
- d. We track the environmental performance of our complete supply chain
- e. We know what chemicals or elements are in our purchased components

**Environmental management systems**

- a. Employees within our firm are evaluated on environmental performance
  - b. Employee reward systems are linked to achieving environmental outcomes
  - c. Environmental performance measures are aligned with our corporate environmental strategy
  - d. Commodity level purchasing strategies are aligned with our corporate environmental strategy
- \*\*

\* Item removed due to low loadings

\*\* Item removed due to cross-loading