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Environmental Management Systems and Green Supply Chain Management: Complements for Sustainability?

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ABSTRACT
Some researchers question the legitimacy of EMSs since organizations can claim to have one when in fact they make no attempt to reduce their environmental harm. In instances where EMSs enhance an organization's environmental performance, critics argue that improvements are likely to occur within the organization's operational boundaries rather than being extended throughout the supply chain. However, previous research suggests that the organizational capabilities required to adopt an EMS may facilitate GSCM implementation and the institutional pressures to adopt both management practices are similar. Consequently, EMS adopters may have a greater propensity to expand their focus beyond their organizational boundaries and utilize GSCM practices to minimize system-wide environmental impacts. This research illuminates the debate by empirically evaluating the relationship between EMS and GSCM practices. Copyright © 2006 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

By April 2005, more than 88 800 facilities worldwide had certified their environmental management systems (EMS) to ISO 14001, the global EMS standard (Peglau, 2005), and thousands more had adopted uncertified EMSs. EMSs are strategic management approaches that define how an organization will address its impacts on the natural environment. While prior

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research has evaluated the reasons why organizations adopt an EMS and the potential these environmental strategies have for improving the environment (Bansal and Hunter, 2003; Darnall, 2006), questions remain about whether organizations are using their EMSs to challenge their supplier networks to become more environmentally sustainable. At issue is that EMSs do not require organizations to improve their environmental performance, but instead focus on creating and documenting environmental polices and procedures (Krut and Gleckman, 1998). Additionally, there is no way of externally verifying that an organization's environmental performance improvements actually occur (Rondinelli and Vastag, 2000). EMSs therefore may represent only symbolic efforts to improve an organization's image (Bansal and Clelland, 2004). In instances where EMSs enhance an organization's environmental performance (Potoski and Prakash, 2005; Khanna and Anton, 2002; King *et al.*, 2005), some scholars suggest that improvements are likely to occur within the organization's operational boundaries rather than being extended throughout the supply chain (Handfield *et al.*, 2004). Moreover, EMS adopters may have little reason to 'green' their supply chains, since they can market themselves as being environmentally proactive (by virtue of having an EMS) without undertaking these additional efforts.

Despite these concerns, the operational capabilities necessary to adopt an EMS may also assist an organization's efforts to reduce its environmental impacts throughout its supply chain (Sarkis, 2001). EMS adopters therefore may be more likely to rely on their complementary knowledge-based capabilities towards working with their networks of suppliers and customers to minimize system-wide environmental impacts. In other instances, organizations that chose to adopt an EMS may endure the same institutional pressures as organizations that adopt GSCM practices, which is why they utilize both environmental management practices simultaneously. Regardless of the nature of their potential complementarity, organizations that adopt EMSs may have a greater probability of implementing environmentally sustainable management practices by considering their environmental impacts beyond their organizational boundaries.

This research examines the potential EMSs have for promoting environmental sustainability through their networks of suppliers and customers. It characterizes the relationship between EMSs and GSCM practices and offers empirical evidence indicating whether EMSs complement GSCM strategies.

Environmental Management Systems

An EMS consists of a collection of internal policies, assessments, plans and implementation actions (Coglianese and Nash, 2001) affecting the entire organization and its relationships with the natural environment. Although the specific institutional features of EMSs vary across organizations, all EMSs involve establishing an environmental policy or plan; undergoing internal assessments of the organization's environmental impacts (including quantification of those impacts and how they have changed over time); creating quantifiable goals to reduce environmental impacts, providing resources and training workers; checking implementation progress through systematic auditing to ensure that goals are being reached; correcting deviations from goal attainment and undergoing management review (Coglianese and Nash, 2001). Based on Deming's (1986) continuous improvement model, EMSs are intended to help organizations embed environmental practices deep within their operational frameworks so that protecting the natural environment becomes an integral element of their overall business strategy (Shireman, 2003). For these reasons, EMSs increasingly are being recognized as systematic and comprehensive mechanisms for improving environmental and business performance (Curcovic *et al.*, 2000).

Once an organization implements an EMS, it may elect to have it certified to the ISO 14001 standard. Developed by the International Organization for Standardization (ISO) in 1996, ISO 14001 adoption

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requires certification by an independent third party auditor, who helps to ensure that the EMS conforms to the ISO 14001 standard. In preparation for certification, an organization must characterize the procedures and plans that form its EMS. Once certified, the ISO 14001 label indicates that the organization has implemented a management system that documents the organization's pollution aspects and impacts, and identifies a pollution prevention process that is continually improved over time (Bansal and Hunter, 2003; Darnall, 2006).

Organizations that adopt EMSs, regardless of their form, can benefit from improving their regulatory compliance, which in turn can enhance their corporate image and increase profits (Stapleton *et al.*, 2001). For example, Federal Foam Technologies, Inc., a Minnesota-based company, adopted an EMS and certified it to ISO 14001. By relying on its EMS structure, the firm reduced its annual landfill use by 40 percent, and decreased its associated disposal costs and liability risks (MPCA, 2001). EMSs also have been associated with improved manufacturing efficiency, customer satisfaction, and new access to markets (Darnall *et al.*, 2001). To the extent that EMSs improve an organization's environmental performance (Potoski and Prakash, 2005; Khanna and Anton, 2002; King *et al.*, 2005), they also may increase its economic gains through enhanced operational efficiencies (Russo and Fouts, 1997; Porter and van der Linde, 1995).

Interest in EMSs extends beyond the organizations that adopt them. Regulators are especially interested in their potential to achieve greater environmental protection. For example, within the US, the Environmental Protection Agency (EPA) is providing leadership in the development of EMSs and promoting wider adoption of EMSs across a range of organizations and settings (USEPA, 2001). Regulator interest in EMS is based on the notion that the benefits associated with reducing pollution can be enjoyed by society at large (Coglianese and Nash, 2001; Ortz, 1995; Fiorino, 1999; Curcovic *et al.*, 2000).

However, in spite of the burgeoning interest in EMSs and the benefits they offer, we know very little about the relationship these systems have with an organization's supply chain and whether EMS adopters promote GSCM practices. Questions arise since EMSs do not require organizations to evaluate the environmental impacts of their supply chains. Rather the EMS focus generally extends to the organization's boundaries (Handfield *et al.*, 2004). While EMSs have been linked to stronger environmental performance than other voluntary environmental techniques – such as corporate environmental reporting (Annandale *et al.*, 2004), this improved performance may occur only within the organization's internal operations. In other instances, improved performance may not occur at all (Krut and Gleckman, 1998), because some organizations may be adopting EMSs symbolically in an effort to enhance their reputation without reducing their environmental impact (Bansal and Hunter, 2003), since there is no way for external stakeholders to verify whether environmental performance improvements actually occur (Rondinelli and Vastag, 2000). Related to GSCM practices EMS adopters may be less likely to utilize since their EMS allows them to market their environmental proactiveness without burdening their supply chain (Krut and Gleckman, 1998). This issue may be of particular relevance since some scholars argue that GSCM practices have relatively little reputational consequences that affect the end customers' purchasing decisions (Preuss, 2005). Even for the most widely recognized EMSs, which undergo external certification (such as ISO 14001), organizations are not required to engage their suppliers (Krut and Gleckman, 1998).

For these reasons, questions remain about whether or not EMSs lead to meaningful environmental improvements (Krut and Gleckman, 1998; Honey and Stewart, 2002) outside their organizational boundaries. However, in practice EMSs may encourage some organizations to expand their environmental considerations beyond their internal operations to their suppliers and customers. If so, EMS adopters may create additional opportunities to enhance environmental sustainability by reducing pollution throughout their supply chain.

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Green Supply Chain Management

The supply chain consist of all parties who are involved in fulfilling a customer request, including the suppliers, transporters, warehouses, retailers and customers themselves (Cox, 1999). The most common GSCM practices involve organizations assessing the environmental performance of their suppliers, requiring suppliers to undertake measures that ensure environmental quality of their products, and evaluating the cost of waste in their operating systems (Handfield *et al.*, 2002). However, GSCM practices also extend to the entire value chain (from supplier to consumer) when organizations inform buyers of ways to reduce their impacts to the natural environment (Handfield *et al.*, 2004). Each of these actions has the potential to reduce the *direct* and *indirect* environmental impacts of an organization's final product.

An organization's *direct* environmental impacts stem from inputs that increase waste during product storage, transportation, processing, use or disposal. These impacts originate from an organization's first tier suppliers. *Indirect* environmental impacts relate to an organization's second tier suppliers' products (or suppliers further upstream), which produce inputs used in the first tier supplier's production process. These inputs have an indirect impact on the final producer's products, production waste and disposal (Handfield *et al.*, 2004). As such, organizations that purchase inputs from a specific supplier also acquire waste from each supplier up the supply chain. These distinctions are important because organizations that adopt GSCM practices generally evaluate the environmental impacts of their first tier suppliers (Handfield *et al.*, 2002), but often do not control for the impact of waste streams beyond first tier since they lack the internal process to do so. While this narrow focus is a shortcoming in some applications of GSCM, historically most organizations rarely restrict their purchasing decisions to suppliers (at any level) with certain environmental criteria (Preuss, 2005).

In recent years, some organizations have begun relying on their supply chains to improve their business performance and create value for their end customers (Handfield and Nichols, 2002). Manufacturers also are calling on their suppliers more frequently to create innovative ideas that exploit new emerging technologies, and reduce costs during the design and development of their products (Handfield *et al.*, 1999). In some instances, organizations are even relying on their suppliers to deliver state-of-the-art process technology that they cannot develop internally. Consequently, enterprises wishing to minimize their environmental impacts during product design are learning that their ability to do so often is dependent on their ability to manage their increasingly complex supplier relationships. For instance, to avoid environmental risks from its suppliers, Dow Chemical, one of the largest global producers of chlorine, partnered with its transportation supplier to design rail cars that were two times thicker than was required by US regulations and by the chemical industry association. The company's decision was based on a discovery that, in the event of a derailment, the rail car had a significant probability of puncturing upon impact and placing neighboring communities and ecological systems at risk. However, Dow lacked the internal expertise to address the problem on its own. By collaborating with its transportation supplier to design an innovative car that would not rupture, the new rail car soon became the industry standard. Consequently, Dow Chemical established a leadership position and increased its credibility with regulators and industry peers. Similarly, in the automotive industry, some manufacturers have formed partnerships with their paint and related chemical suppliers in an effort to develop innovative environmentally benign inputs that car makers could not develop on their own (Geffen, 1997; Geffen and Rothenberg, 2000).

In other instances, organizations are focusing more tightly on their core competencies and relying on their suppliers to a greater degree for non-core activities such as new product development through early design and concurrent engineering (Prahalad and Hamel, 1990; Ragatz *et al.*, 2002). These

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organizations are choosing to green their supply chain to avoid inheriting environmental risks from less environmentally conscious suppliers (Klassen and Whybark, 1999). The global automotive industry is an example of one sector that collectively is considering the environmental attributes of its suppliers to avoid environmental risks. For instance, by evaluating the plastic and steel components in its product design cycle, the automotive industry has reduced its risk of inheriting environmental problems from its suppliers and minimized its long-term environmental liabilities (Gupta and Piero, 2003). Similarly, in 2002, Hewlett-Packard established its Supply Chain Social and Environmental Responsibility Policy. The company also instituted a supplier code of conduct. Combined, these efforts have extended Hewlett-Packard's corporate social responsibility commitment by incorporating its global supply base and reducing its supply chain risks.

Like EMSs, regulators also have expressed interest in GSCM practices by encouraging their more widespread use. For example, in 2000, the US EPA's Design for the Environment (DfE) program funded a partnership between EPA, the University of Tennessee and Saturn Corporation to explore different methods of promoting environmental improvement throughout Saturn's supply chain (Loveday, 2000). Building on this effort, in 2001, EPA established a pilot program with General Motors Corporation (GM) to develop a multimedia technical assistance program aimed at pollution prevention in GM's supply chain (USEPA, 2003). More comprehensive collaborations within the automobile industry include a partnership between EPA and automobile suppliers to create The Suppliers Partnership for the Environment, a trade association comprised of automotive and vehicle suppliers seeking to create new and innovative business-centered approaches to environmental protection. The partnership provides a forum for automobile producers and suppliers to share environmental best management practices and to promote GSCM practices (Jusko, 2003). Like their interest in EMSs, regulators are encouraging organizations to adopt GSCM practices because they believe that organizations that implement them will reduce their impact on the natural environment and therefore benefit society as a whole.

Relationship Between EMS Adoption and GSCM Practices

The relationship between EMSs and GSCM practices has potentially complementary and significant implications for an organization's environmental sustainability, because together they offer a more comprehensive means of defining and establishing sustainability among networks of business organizations. However, when EMSs are adopted in the absence of GSCM, environmental benefits are likely to diminish. This is because the organization's supply chain network does not share its environmental goals, and environmental sustainability of any organization is impossible without incorporating GSCM practices (Preuss, 2005).

For instance, an organization may adopt an EMS and significantly enhance the environmental performance within its organizational boundaries, but its suppliers may not do the same. In other instances suppliers may *increase* their buyers' environmental harm. One example is seen in the US furniture manufacturers industry, where some furniture manufacturers have implemented GSCM practices to purchase wood from tier one suppliers that utilize sustainable forestry. However, many of these furniture manufacturers have no systematic process to identify whether their tier one suppliers apply the same restrictions on tier two suppliers. As such, tier one suppliers may increase their environmental harm, despite the fact that they utilize sustainable forestry practices. The net effect may be an overall reduction in environmental sustainability, which is why companies implementing decisions across a network of organizations often see deteriorated system-wide performance (Nohria and Eccles, 1992), and why managing the entire supply chain is critical to achieving environmental sustainability goals.

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Some organizations have recognized these linkages and are responding by instituting coercive environmental mandates on their suppliers. As part of its EMS, for example, British Petroleum is requiring its suppliers to adhere to specific GSCM practices that are consistent with the organization's environmental goals. These new supplier mandates are helping the company develop stronger delivery systems for its input stock of recycled materials throughout its supply chain. In so doing, BP hopes to increase environmental sustainability across its supplier network and improve environmental performance system-wide.

Capabilities for Adopting EMS and GSCM

There are numerous capabilities required to adopt an EMS that reduce the cost of adoption (Darnall and Edwards, 2006) and facilitate the implementation process. For instance, EMS adoption requires that an organization encourage its employees to work together, sharing their knowledge of the organization's internal operations in order to minimize impact to the natural environment (Hart, 2005). It also requires an organization-wide commitment to continually improve the organization's environmental impacts and extensive knowledge and monitoring of organizational resources, constraints, production capabilities and processes (ISO, 2001). Because their focus is on continual improvement, EMSs encourage enterprises to rely on lean production practices that promote reductions in input use, which are important for minimizing impacts to the natural environment (Darnall and Edwards, 2006).

Similarly, organizations that have expertise with GSCM have developed their knowledge-based competencies by guaranteeing the environmental quality of incoming goods. Like EMSs, GSCM practices require organizations to have strong inventory control systems. These systems reduce redundant stock materials and unnecessary inputs in the production process (Rosenberg and Campbell, 1985). Organizations that rely on these systems manage materials, productive capacity and other organizational information (Rosenberg and Campbell, 1985). The skills required to adopt GSCM are therefore complementary to the capabilities required for the successful adoption of EMSs inasmuch as both systems encourage enterprises to reduce input use and decrease waste associated with input choices, which are important for minimizing impacts to the natural environment.

At their core, both EMS and GSCM rely on what on Deming's (1986) continuous improvement model. EMSs are systems of management processes that enable organizations to continually reduce their impact to the natural environment (Darnall and Edwards, 2006). Similarly, GSCM practices leverage continual improvement processes that reduce the impact of supplier inputs on the organization's final product (Preuss, 2005). The continual improvement capabilities necessary to maintain an EMS and implement GSCM practices can both be used to facilitate the introduction of pollution prevention programs and capabilities in cross-functional management that advance product stewardship goals. These capabilities also can be used to encourage EMS adopters to more readily determine the root cause of their environmental impacts, which may identify opportunities across their supply chain to improve environmental performance.

Organizations that adopt EMSs must think holistically about their impacts on the natural environment (Coglianese and Nash, 2001). In so doing, these organizations plan strategically for the long term and develop a capacity to assess their progress toward achieving desired outcomes (Kitazawa and Sarkis, 2000). EMS adopters have also developed a culture that embraces internal evaluations that help push the organization towards achieving greater organizational efficiency (Lawrence and Morell, 1995; Welford, 1992) – both within and across operational units – which is critical for continuous environmental improvement (Netherwood, 1998). For these reasons, EMS adopters may have greater ease during GSCM implementation because they possess the internal tacit knowledge required to manage

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the environmental impacts of their supply chain, and are more likely to collaborate across the organization's internal departments to improve the environment.

Collaboration across internal departments is essential to maintaining robust GSCM practices. For instance, in utilizing GSCM, an organization must coordinate its product design department with its marketing department and its suppliers in an effort to minimize waste and environmental impact at every node in the supply chain (Handfield *et al.*, 2001). However, traditional organizational structures generally are fragmented with purchasing departments operating separately from marketing and sales, and operations functioning independently from human resources, with each having their own goals (Trowbridge, 2001). One way that organizations are managing these relationships is to implement 'product design teams' that include representatives from numerous internal departments as well as suppliers who discuss environmental issues throughout product design. These teams often rely on lifecycle analysis to ensure minimal impact from raw material extraction to final disposal (i.e. cradle to grave) (Heiskanen, 2000). Similar to EMSs, which encourage cross-departmental coordination, implementing GSCM practices such as these requires an organization's internal departments and suppliers to reorient their operations so that they collaborate to pursue a common environmental goal.

In other instances, organizations that implement EMSs build on their existing knowledge and proficiencies in pollution prevention (Darnall and Edwards, 2006) and therefore can more easily address the environmental impacts of their supply chain. These organizations have invested in training their employees to improve the organization's environmental management and assess their production processes continually so as to eliminate inefficiencies. They also systematically evaluate and share knowledge about the organization's environmental impacts (Hart, 1995). By encouraging their employees to work together in teams and continually improve the organization's environmental performance (Kitazawa and Sarkis, 2000), companies may be able to leverage their pollution prevention skills and environmental knowledge toward other integrated forms of environmental management (Hart, 1995; Darnall and Edwards, 2006) such as GSCM practices. EMSs therefore offer a management structure to support supply chain management decisions that affect the natural environment, and, consequently, organizations that have experience with EMS may find it easier to adopt GSCM practices because they require similar complementary capabilities. While GSCM activities are likely to involve greater contact with third parties than EMSs, which may require an additional skill outside of the EMS framework, the internal expertise required to assess product inputs appears complementary to both management practices.

External Pressures for Adopting EMS and GSCM

Other reasons why EMS and GSCM may be considered complementary management practices relate to the institutional pressures that encourage their adoption. Institutional pressures persuade organizations to undertake similar strategic actions (Hoffman, 1997; Scott, 2001) to increase their external legitimization (DiMaggio and Powell, 1983; Hoffman and Ventresca, 2002). Legitimate businesses are those whose actions are seen or presumed to be desirable or appropriate within some socially constructed system of norms, values, beliefs and definitions (Suchman, 1995). Applied to the decision to adopt an EMS and GSCM practices, the external pressures an organization endures to implement one practice may be similar in that they arise from regulators, markets and communities.

Regulatory pressures are often associated with an organization's decisions to adopt an EMS (Darnall, 2003) and utilize GSCM practices (Birett, 1998). These pressures arise from threats of noncompliance penalties and fines (Davidson and Worrell, 2001) and requirements to publicly disclose information about toxic chemical releases (Konar and Cohen, 1997). For instance, regulatory changes in automotive paints have pressed car manufacturers to require their suppliers to reduce their use of regulated chemicals in the production process (Geffen and Rothenberg, 2000). Additionally, pressures from regulators

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may encourage organizations to adopt proactive environmental practices in an effort to form collaborative relationships and explore more non-regulatory ways in which government can encourage greater environmental improvements (Andrews *et al.*, 2003). These less coercive forms of regulatory pressure are becoming increasingly relevant as governments expand their programs that encourage EMS adoption and GSCM practices. In adopting EMSs and relying on GSCM practices, organizations may be able to communicate more effectively to government that they are committed to improving their environmental performance.

In addition to regulatory pressures, market pressures may influence an organization's decision to adopt EMSs (Darnall, 2003) and rely on GSCM practices (Rao, 2002; Gupta and Piero, 2003). Over the last ten years, market actors have been placing greater pressures on organizations to consider their impacts on the natural environment (Hoffman, 2000). Overall, 15 percent of US consumers routinely pay more for green products, and another 15 percent seek green products if they do not cost more (Ginsberg and Bloom, 2004). While these findings suggest that markets are creating opportunities for environmentally friendly organizations, the majority of consumers still are not influenced by a company's proactive environmental practices. However, these same customers may be persuaded to change their purchasing decisions if a company violates environmental laws or emits high levels of toxins (Prakash, 2000). As a consequence, EMS and GSCM adoption may provide a vehicle for organizations to 'signal' to market participants that their environmental strategies adhere to or exceed generally accepted environmental standards. Doing so may lead to greater acceptance of the organization's strategic approach (DiMaggio and Powell, 1983) and insulate organizations from competitors' criticisms (King and Lenox, 2001). EMS and GSCM adoption also may help organizations develop an environmentally conscious reputation. Such a reputation may invite patronage from consumers and generate opportunities for business with other organizations that value these principles (Darnall and Carmin, 2005).

Finally, organizations are subject to pressures from the community that include environmental groups, community groups, the media, labor unions and industry associations (Hoffman, 2000). Each of these groups can marshal public support for or against an organization's environmental performance (Clair, Milliman and Mitroff, 1995; Turcotte, 1995). EMS and GSCM adoption may be one way for organizations to indicate to community stakeholders that their environmental management practices are sound. Doing so is increasingly important because community stakeholders often do not distinguish between an organization's environmental practices and the practices of its suppliers (Rao, 2002).

In sum, EMSs and GSCM practices may be complementary because organizations that adopt them possess comparable internal competencies and endure similar institutional pressures. For these reasons, we hypothesize that EMS adopters are more likely to utilize GSCM practices.

Hypothesis: EMS adopters are more likely to utilize GSCM practices.

Research Methodology

To evaluate our hypothesis, we relied on data collected from a 12-page survey developed by the Organisation for Economic Co-Operation and Development (OECD) Environment Directorate and academic researchers. The OECD survey was pre-tested and validated for accuracy. In 2003 the survey was mailed to environmental managers of 3746 US manufacturing facilities. The survey targeted facilities that had 50 employees or more and that reported data to EPA's Toxic Release Inventory. Relying on Dillman's (1978) 'total design method', the OECD sent two follow-up mailings to prompt additional responses, and 489 facility managers completed the survey. The response rate was 13 percent, which is similar to previous studies of organizations' environmental practices (e.g. Christmann, 2000; Delmas and Keller,

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2005; Melnyk *et al.*, 2003).[1] Almost half of the sample was either small- or medium-sized enterprises (<250 employees).

The OECD database contains information on the environmental activities of *facilities*. Undertaking a facility level analysis was important because facility level factors often explain the *degree of implementation* for most environmental initiatives to a greater extent than firm level factors (Bowen, 2002). Moreover, facility level analyses often shed more light on the operational mechanisms that underlie environmental management (Klassen and Whybark, 1999). That is, while requirements for EMS adoption may occur at the corporate level (Darnall, 2006), strategy implementation often varies among facilities within the same firm.

To check for common method variance, we relied on the *post hoc* Harman single-factor test (Podsakoff and Organ, 1986). The basic assumption of this test is that if a substantial amount of common method variance is present, a factor analysis of all the data will result in a single factor accounting for the majority of the covariance in the independent and dependent variables. The results of Harman's single-factor test revealed that no single factor accounted for the majority of the variance in the variables, offering evidence that this type bias was not a concern. Social desirability bias was addressed by ensuring anonymity for all respondents. Additionally, survey questions related to GSCM were separated from questions pertaining to EMS adoption. In instances where a social desirability bias exists, researchers are less likely to find statistically significant relationships because there is less variability in respondents' survey answers. However, by finding statistically significant relationships, additional evidence would be offered about the strength of the relationship between the variables of interest (Hardin and Hilbe, 2001). Non-response bias was checked by using the method by Armstrong and Overton (1977) of comparing the responses of late respondents with those of early respondents. No significant differences were found. Issues related to generalizability were less of a concern because the OECD survey had broad applicability in that it targeted multiple industry sectors in multiple countries. However, to address this potential concern, the OECD examined the general distribution of respondents (by considering industry representation and facility size) relative to the distribution of facilities in the broader population. It found no statistically significant differences (Johnstone *et al.*, 2006).

Measures

EMS adoption was assessed in four ways. First, we relied on OECD data that asked facilities whether they were in the process of EMS adoption, or whether they had adopted a certified or non-certified EMS. Second, we utilized OECD survey data that asked whether facilities had adopted a written environmental policy, implemented environmental training programs for employees, carried out internal environmental audits, relied on external audits, utilized environmental performance indicators and goals, and adopted environmental criteria to evaluate employee performance. Each of these elements is considered a component of an EMS (Netherwood, 1998), and was evaluated individually, because some organizations may claim to have an EMS when in fact they only have portions of one.

For our third EMS measure, we created a variable called 'total EMS' to account for whether or not facilities implemented all six elements of an EMS. Finally, organizations with more mature EMSs may implement GSCM practices to a greater degree than organizations with less mature EMSs because they have had time and experience to integrate environmental concerns throughout their management structure. To measure EMS maturity, we relied on OECD survey data that requested facilities to provide the age of their EMS. Although not a perfect measure of EMS maturity, EMS age is indicative of the length of time in which the organization has been continually reducing its environmental impacts.

[1] Response rates were 20.1, 11.2 and 10.4 percent respectively.

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To measure GSCM practices, we utilized OECD survey data that asked facilities whether they assessed the environmental performance of their suppliers, whether they required their suppliers to establish environmental practices and whether they tracked the cost of waste throughout their supply chain (Handfield *et al.*, 2002). In assessing facilities' environmental stewardship goals related to their supply chain, we relied on OECD data that asked whether facilities informed buyers of ways to reduce their environmental impacts (Handfield *et al.*, 2004).

Empirics

To empirically test the association between EMS adoption and GSCM, we relied on three statistical models. Pearson chi-square tests were used to evaluate the relationship between our first three EMS measures and GSCM practices. This test relies on two-way tables of frequency counts to determine the association between two variables. In instances where the expected frequency was low, we relied on Fisher's exact test. Fisher's exact approximates Pearson's chi-square in a nonparametric setting, and in larger samples Fisher's exact estimates are equivalent to chi-square (Stokes *et al.*, 1995). To evaluate the association between EMS age and GSCM, we relied on two-tailed *t*-tests.

Results

Facilities that *were in the process of adopting an EMS* implemented GSCM practices 13–22 percent more frequently ($p < 0.01$) than facilities that had not considered EMS adoption (see Table 1),[2] although they were no more likely to track the cost of waste in their supply chain. Stronger results were seen by facilities that had *completed EMS adoption* in that they implemented GSCM practices between 7 and 29 percent more frequently ($p < 0.01$) than facilities that had not implemented an EMS.

In considering whether GSCM facilities more frequently certified their EMSs to ISO 14001, the results show that 58 percent of ISO 14001 adopters assessed their suppliers' environmental actions ($p < 0.05$) and 57 percent required suppliers to undertake specific environmental activities ($p < 0.01$), as compared to 40 percent and 36 percent of non-certified facilities, respectively. These findings offer evidence that ISO 14001-certified facilities are implementing GSCM activities to a greater extent – at least GSCM activities that relate to evaluating suppliers' environmental practices. However, ISO 14001 certified facilities were no more likely to track the cost of waste in their operations or inform buyers of ways to reduce their impacts to the natural environment than non-ISO 14001 certified facilities.

With respect to the different EMS elements, in all but one instance, facilities that had adopted different aspects of EMSs also adopted all four GSCM practices ($p < 0.01$–0.05). These findings suggest that the different elements of an EMS, which include an environmental policy, environmental training for employees, internal and external audits, using environmental performance indicators and using environmental criteria in employee evaluations, are associated with GSCM practices. The largest difference among all our comparisons was for GSCM adopters and facilities that had adopted all six EMS characteristics ('total EMS'). 'Total EMS' adopters implemented GSCM practices between 19 and 34 percent more frequently than facilities without a total EMS ($p < 0.01$).

Facilities with more mature EMSs did not adopt GSCM practices any more than facilities with less mature EMSs. Combined with our other findings, these results suggest that GSCM adoption rates were higher for EMS adopters regardless of how long their EMS had been in place, offering support for our hypothesis that EMS adopters are more likely to utilize GSCM practices.

[2] These values were determined by subtracting the percentage of EMS adopters that implemented GSCM practices from the percentage of non-EMS adopters with GSCM practices in Table 1.

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Facility characteristic	Facility comparisons+			
	Assess suppliers' environmental performance	Require suppliers to undertake environmental measures	Track the cost of waste	Inform buyers of ways to reduce environmental impact
• In the process of adopting an EMS	48%***	34%***	51%	32%***
Non-EMS adopting facility	26%	20%	47%	19%
(*n* = 309, 308, 292, 308)				
• Completed EMS adoption	51%***	49%***	69%***	36%***
No EMS & not in process of adoption	26%	20%	61%	19%
(*n* = 371, 367, 354, 365)				
• Certified to ISO 14001	58%**	57%***	59%	39%
Facility not certified to 14001	40%	36%	67%	31%
(*n* = 167, 164, 164, 162)				
• Written environmental policy	44%***	36%***	54%	30%***
No written environmental policy	12%	13%	47%	15%
(*n* = 474, 470, 457, 468)				
• Environmental training for employees	43%***	36%***	56%***	30%**
No environmental training for employees	13%	8%	28%	15%
(*n* = 476, 472, 460, 470)				
• Internal environmental audits	41%***	34%***	55%***	29%**
No internal environmental audits	17%	14%	27%	11%
(*n* = 473, 474, 460, 472)				
• External environmental audits	49%***	43%***	57%**	34%***
No external environmental audits	23%	16%	46%	18%
(*n* = 473, 468, 458, 467)				
• Environmental performance indicators	47%***	40%***	58%***	34%***
No environmental performance indicators	23%	16%	43%	16%
(*n* = 474, 469, 459, 468)				
• Environ. criteria used in employee evaluations	49%***	45%***	64%***	40%***
No environmental criteria used in evaluations	34%	27%	48%	22%
(*n* = 469, 464, 453, 463)				
• Total EMS	61%***	60%***	68%***	51%***
No total EMS	34%	26%	49%	22%
(*n* = 467, 462, 452, 461)				
• EMS maturity for GSCM facility	3.8	4.0	3.9	3.5
EMS maturity for non-GSCM facility	2.7	2.6	2.4	2.9
(*n* = 143, 139, 140, 136)				

Table 1. Association of EMS characteristics and GSCM practices
+Top values represent responses from facilities that indicated they implemented the GSCM practice. Bottom values represent facilities that did not implement the GSCM practice.
* Statistically significant at $p < 0.10$; ** statistically significant at $p < 0.05$; *** statistically significant at $p < 0.01$.

Discussion

This study offers empirical evidence for the notion that EMS adopters are engaging their supply chain networks by instituting procedures to assess their suppliers' environmental harm, requiring suppliers to minimize their environmental impacts, tracking waste in their operating systems and informing buyers of ways to minimize their impact to the natural environment. Our results were consistent across

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organizations that reported they were in the process of EMS adoption, had fully completed EMSs, had externally certified EMSs and had adopted different (or all) elements of a typical EMS.

These findings are important for three reasons. First, the legitimacy of EMSs has been questioned since an organization can claim to have one when in fact it makes no attempt to reduce its environmental harm (Krut and Gleckman, 1998; Honey and Stewart, 2002). In instances where EMSs improve an organization's environmental performance (Potoski and Prakash, 2005; Khanna and Anton, 2002; King *et al.*, 2005), improvements are likely to occur within the organization's operational boundaries rather than being extended throughout the supply chain (Handfield *et al.*, 2004). However, the results of this study indicate that EMS adopters are taking steps to reduce the environmental impact of their supply chains. More specifically, EMS adopters are more likely to impose indirect control mechanisms on suppliers, which are more likely to improve environmental performance, increase product quality and delivery, and reduce operational costs. As such, EMS adopters are more likely than non-adopters to improve the environmental sustainability of their organization and their network of suppliers and buyers. These networks are critical factors that are often ignored when defining the sustainability of business organizations (Sarkis, 2001).

Second, our study has important implications for managers. Organizations that have adopted EMSs may possess capabilities that are complementary to GSCM practices. That is, EMS adopters may be transferring their complementary organizational expertise and resources towards managing the environmental impacts of their supply chain, since doing so makes the implementation of GSCM practices less costly. Similarly, organizations that have invested in implementing GSCM practices, but have not gone the extra step to formalize their EMS, may be able to adopt an EMS with fewer resources. They also may be responding to external pressures from regulators, markets and communities for greater environmental consideration. These findings may encourage managers who are seeking to implement sustainable practices within their organizations to consider the connection between EMS and GSCM (and vice versa) and how their organization may benefit by adopting both practices.

In considering the motivations to adopt EMS and GSCM together, additional research is needed to understand the extent to which an organization's internal capabilities or external pressures dominate the relationship. For instance, while an organization's external pressures may influence the adoption of both management practices, its internal capabilities may be the primary driver. These differences may explain subsequent variations in an organization's environmental performance in that companies with stronger complementary capabilities prior to EMS and GSCM adoption may improve their environmental and business performance to a greater degree than organizations that adopt both management practices due to external pressures alone. Studying the relative contribution of both theoretical perspectives would enhance our understanding of the benefits of undertaking proactive environmental strategies to a much greater degree.

Our third contribution relates to public policy. Within the US, EPA is trying to encourage additional organizations to adopt EMSs and implement GSCM practices through the use of voluntary environmental programs and partnerships with organizations. However, the agency has not yet implemented a program that considers the two environmental management strategies in tandem. Regulators may be able to capitalize on the complementary nature of EMSs and GSCM practices to encourage organizations to integrate their environmental practices to a greater degree. For instance, regulators may be able to persuade additional organizations to implement GSCM practices by offering incentives to organizations that have already adopted EMSs. Similarly, organizations that have already adopted GSCM practices may be more easily persuaded to adopt an EMS. This complementarity is important because organizations that adopt GSCM practices often do not control for the impact of waste in upstream suppliers (Handfield *et al.*, 2002). Moreover, in evaluating the waste of first tier suppliers, most GSCM efforts focus on packaging and waste rather than the process by which suppliers produce their product

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inputs (Preuss, 2005). By supplementing their GSCM practices with an EMS, organizations may be able to further enhance their GSCM activities by creating an internal process to assess suppliers' production procedures and continually reduce the impacts of all upstream suppliers. Doing so may further benefit the environment, thereby helping to achieve regulatory goals.

Finally, this study has important implications for future research that explores the relationship between EMS and GSCM practices. It would be important to know whether organizations achieve greater internal efficiencies if they adopt EMS and GSCM practices in a particular sequence and what capabilities are needed to be in place prior to endeavouring either management practice. It would also be important to know whether organizations that adopt both EMS and GSCM practices improve their environmental and business performance more than organizations that simply focus on one practice alone. If so, a stronger business case could be made about the merits of organizations undertaking a network-wide approach to environmental management.

Conclusion

In sum, this research reveals that organizations that adopt EMSs more frequently implement GSCM practices, regardless of how long the EMS has been in place. These results suggest that EMSs and GSCM may complement each other, and that EMS adopters have a stronger probability of improving the environment not just within their organizational boundaries, but throughout their network of buyers and suppliers. The net effect may be an overall increase in environmental sustainability, since mechanisms are in place to enhance network-wide environmental performance.

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