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Green supply chain management and organizational performance

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Abstract

Purpose – The purpose of this study is to explore green supply chain management (GSCM) practices and their relationship with organizational performance. More specifically, this research explores the effect of GSCM efforts and other organizational factors on firm performance of small and medium enterprises (SMEs) that serve as suppliers to large customer firms in the electronics industry.

Design/methodology/approach – This study developed a research model relating GSCM practice and business performance through three organizational variables (employee satisfaction, operational efficiency, and relational efficiency) as moderators. Statistical analyses were based on the data collected, through survey questionnaires, from 223 SMEs in the electronics industry in Korea. Reliability, validity, and goodness-of-fit of the research model were tested by the widely accepted statistical tools. To test the hypotheses relating GSCM practice implementation and business performance, structural equation modeling was used.

Findings – The most anticipated finding of the study was a direct link between GSCM practice implementation and business performance. However, no statistical significance was found. Instead, significant indirect relationships were found between GSCM practice implementation and business performance through mediating variables of operational efficiency and relational efficiency. This result indicates that business performance will be improved when GSCM enhances operational efficiency and operational efficiency.

Research limitations/implications – Research on GSCM is still at the early stage. Further refinement of the questionnaire is needed. Generalizability of the findings is also limited because of data collected from electronics firms in Korean. This study shed several important insights. The findings of this study are generally consistent with prior studies in other parts of the world. SMEs in the Korean electronics industry believe that GSCM practices help generate new opportunities to attract clients in addition to complying with the buyer firms' demand. It was also found that implementation of GSCM practices help improve operational and relational efficiencies of supplier firms.

Originality/value – Few empirical studies have been done in GSCM based on the conceptual footing of resource dependence theory. Also, this study was conducted from the supplier's perspective in examining the weaknesses of SME suppliers. Thus, the authors emphasize the importance of support from large buying firms for improving SME suppliers' green management capabilities.

Keywords Green supply chain management, Electronics industry, Small and medium enterprises, Business performance, Small to medium-sized enterprises, Supply chain management, Republic of Korea

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Introduction

Globalization has changed not only the range of potential competitors but also the possible horizon of expansion and organizational structures. Krueger (1998) argued for the following benefits of globalization:

- contractors in developing countries may gain more knowledge from the interactions with their foreign buying firms and as a result attain higher productivity; and
- exporters benefit from trade liberalization by achieving higher levels of efficiency more rapidly and economies of scale which are limited in protected nations.

In the past couple of decades, multinational enterprises (MNEs) began to accept the necessity of environmental management and started to implement environmental management programs to compete in the global market.

In the resource dependence perspective, establishing inter-organizational collaboration is essential to gain competitiveness, especially as risks in firms' global supply chains have been amplified and relying solely on internal resources is not sufficient to compete with other global firms (Pfeffer and Salancik, 1978). As a matter of fact, while making major efforts in greening their supply chains to maintain competitiveness in the global market, MNEs have paid less attention to their upstream members in the supply chain (Lee and Klassen, 2008; Lee, 2009). One of the major reasons that focal firms should be interested in supply management is that it is still the firms' responsibility to the public even if incidents occur in the upstream of the firms' supply chains. Some of the best known cases are: Mattel's Fisher-Price recalled over 10 million lead-painted toys (Burke, 2007), McDonald's fiasco with 12 million drinking glass gift sets (Pepitone, 2010), and 1.3 million Sony PlayStations seized by The Netherlands Government because of excessive cadmium detected from the game consoles (Franklin, 2004; Carlton, 2006). Many studies argue that the main reason that suppliers cause such problems is because they are mostly small- and medium-sized enterprises (SMEs) which often lack human resources with expertise on Restriction of Hazardous Substances (RoHS) Directive compliance, as well as financial resources to initiate expensive environmental management systems (EMSs) such as ISO 14001 (Lee, 2009).

In the supplier firms' perspective, the current situation could create potential business opportunities. Supplier firms that have already implemented EMSs are in a better position to win more business from large customer firms. Many buying firms are demanding that their suppliers implement green supply chain management (GSCM) practices and fulfill even additional environmental requirements (Jabbour and Jabbour, 2009; Lee, 2009). On the other hand, because large manufacturers have been adopting environmental audit programs to better control their vendors, these suppliers have been able to keep and extend their current contracts (Lee, 2009). In fact, suppliers will be hard pressed to find any business opportunities elsewhere without initiating GSCM practices (Nishitani, 2010).

This study focuses on GSCM practice of SMEs in the electronics industry. We aim to explore the direct and indirect paths of related factors between the implementation of GSCM practices and the firm's business performance outcome. The results of statistical analyses of the collected data from operations managers will enrich this research on GSCM. Furthermore, the results of this research will provide new insights

to SMEs, which are planning or currently implementing GSCM practices, toward enhancing their green operations for better performance outcomes.

This paper is organized as follows. Second section provides background of the study. It describes the fast changing environment in which firms compete and the characteristics of SMEs. In Third section, we develop hypotheses based on previous studies. Fourth section describes research methods including data collection and test of hypotheses. Fifth section presents the results and sixth section discusses the findings of the study.

Literature review

RDT and organizational performance

Organizations are highly dependent on their environments and tend to continuously adapt to external change dynamics (Hage and Aiken, 1967). Cook (1977) explained that dependencies in a business relationship are developed among trading partners, and through such dependencies the partners have impact on each other's business practices and eventually business performance. In the resource dependency perspective, few organizations are internally self-sufficient with respect to their strategically critical resources (Heide, 1994), and they depend on external resources to secure their competitiveness (Pfeffer and Salancik, 1978). In other words, organizations that lack vital resources to accomplish their goals must seek competitiveness by building relationships with partner organizations to obtain required resources (Pfeffer and Salancik, 1978).

According to resource dependence theory (RDT), firms also seek to reduce uncertainty and manage dependence by purposely structuring their exchange relationships, establishing formal and semiformal linkages with other firms (Ulrich and Barney, 1984). Pfeffer and Salancik (1978, p. 145) discuss four fundamental benefits of the formal linkages with other organizations, as it:

(1) provides information about the activities of that organization which may have influence on the focal organization;

(2) provides a communication channel for information;

(3) offers an important first step in obtaining commitments of support from important elements of the environment; and

(4) has a certain value for legitimating the focal organization.

In practice, firms can reduce uncertainty through negotiations and agreements with collaborating firms (Koberg and Ungson, 1987; Cai and Yang, 2008). What plays an important role, in addition to the formal linkages, is semiformal linkages (Pfeffer and Salancik, 1978) such as maintaining a social bond between interdependent others, so that they can establish trust-based relationships.

In summary, through such interdependence, firms can synergistically combine their own resource sets with the complementary resources of their partners and thus develop a resource bundle that is unique and hard to imitate (Harrison *et al.*, 2001). By cultivating such relationship-specific capabilities that become superior to what the organizations may possess on their own (Dyer and Singh, 1998; Harbison and Pekar, 1998), firms can obtain sustainable competitive advantage and improved organizational performance (Sambharya and Banerji, 2006; Paulraj and Chen, 2007).

RDT and SCM

In the traditional supply chain, each member organization attempts to avoid becoming overly dependent on others for fear of being exploited. Firms usually believe that they could ignore component dependencies in the supply chains. They also make efforts for effective decision-making with their existing facilities and business processes (Thomas and Griffin, 1996). At the same time, they believe that making others dependent on them could possibly create a position of strength (Ketchen and Hult, 2007). However, the focus of the definition of SCM has shifted. The early definition of SCM took into consideration the integration of a firm's internal functional groups, such as purchasing, manufacturing, and distribution (Harland, 1996). Currently, the definition of SCM pays attention to the interdependence in the broader, global perspective. For example, the Global Supply Chain Forum defines, "Supply chain management is the integration of key business processes from end-user through original suppliers that provides products, services, and information that add value for customers and other stakeholders" (Lambert *et al.*, 1998).

In the past decades, firms moved their production facilities and business departments offshore to benefit from lower production and service costs (Gupta, 2009; Kumar *et al.*, 2009). Hence, many global firms have managed global supply chains that consist of manufacturing and distribution units throughout the world. Due to the distance and cultural diversity, it is challenging for the focal firms to develop and execute integrated strategic, tactical and operational manufacturing, as well as distribution plans of plants scattered over the world (Ueltschy *et al.*, 2007; Miller and de Matta, 2008). Manuj and Mentzer (2008) argue that risks and challenges occur along the entire global supply chains and the new extended supply chains hide a number of potential risks as well. Such unresolved issues as product quality, inventory control, lead time, and buyer-supplier trust could be amplified by new risk factors – distance, language, and cultural diversity besides supply chain disruption by natural disasters. Thus, many firms have attempted to overcome strategic weakness in SCM through inter-organizational dependencies. In this aspect, RDT is a relevant theory to SCM because it can help elaborate organization-environment boundary spanning activities, implying that a single firm can hardly achieve sustainable growth. Therefore, firms need to depend on the buyer-supplier relationship which helps improve cooperation and coordination among supply chain members (Dyer, 2000).

RDT and GSCM

For SCM to be strategic in nature, it is imperative that buyer firms adopt strategic initiatives (i.e. implementation of GSCM practices) that foster an effective relationship to provide mutual benefits (Paulraj and Chen, 2007). In the context of GSCM, inter-organizational collaboration is even more important for managing the internal and external coordination and cooperation to have the system successfully implemented throughout the whole supply chains (Zhu *et al.*, 2010).

The European Union (EU) and the USA introduced new regulations on environmental management several years ago. The EU established strong regulatory systems especially in the electronics and electrical industry, such as the RoHS Directive in electrical and electronic equipment, the directive on Waste Electrical and Electronic Equipment (WEEE); restriction, evaluation, and authorization of chemicals (REACH); and eco-design for energy using products (EuP) (Goodman, 2008; Lee, 2009;

Schneiderman, 2009). The Korean Government also followed the blueprint of the EU's environmental policy with regard to regulating materials to assemble and build electronics, as well as producers' recycling responsibilities (Spiegel, 2008). The life cycle of electronic products is becoming very short. The US Environmental Protection Agency (EPA) reports that about 500 million PCs became obsolete and were thrown away between 2000 and 2007 (www.epa.gov/region8/recycling/ecycling.html). According to the US EPA, electronic waste (e-waste) shows a faster growing trend than any other waste stream, such as paper. This is the major reason that green practices are important in the electronics industry.

To successfully adopt GSCM-related practices, such as green purchasing, eco-design, and cooperation with customers, large manufacturers need not only good internal environmental management but also external cooperation and coordination with suppliers and customers in their supply chain. As discussed above, industries pay attention to the "ecologically responsible design of new products" (Gonzalez-Benito, 2008). The fate of a product, whether or not it produces any pollution or unsafe levels of certain chemicals, is decided "at the design stage when materials and processes are selected" in the product life cycle (Zhu and Sarkis, 2006). Green purchasing practice is comprised of environment-based initiatives, such as supplier environmental audit and assessments and supplier's environmental certification (Hsu and Hu, 2008), so that the buyer firms can receive safe materials. To adopt more proactive strategic SCM, it is essential for manufacturers make collaborative efforts with both the first- and the second-tier suppliers to establish green systems and comply with environmental regulations in producing parts and components (Lamming and Hampson, 1996). For suppliers, cooperation with buyer firms is a critical element in terms of GSCM if buyer firms export and sell their products in the global market. SME suppliers may not be knowledgeable about the environmental requirements in foreign countries. Thus, buyer firms should support suppliers regarding complex regulations that must be complied in various international markets (Lee and Klassen, 2008; Lee, 2009).

SME suppliers and GSCM

In Europe, 76 percent of all corporations are SMEs. These SMEs are responsible for 60-70 percent of all industrial pollution, 40-45 percent of CO_2 emissions, 40 percent of water and energy consumption, and 70 percent of industrial waste production in Europe (Heras and Arama, 2010). As of 2007, South Korean SMEs represent almost 99 percent in the manufacturing industry. Small firms (less than equal to 50 employees) account for 92.7 percent (SBC Research Department, 2009). Most of these SMEs are suppliers to large manufacturers and they are struggling to cope with changes in their business environment. To comply with new environmental regulations, such as WEEE and EuP, leading global corporations in the electronics and information and communication technology (ICT) industries, including Samsung, LG, Sony, and Dell, have implemented EMSs and standards in their SCM. However, a number of suppliers have failed to attain the satisfactory grade on their environmental performance by their buying firms as well as consumers (Peres and Stumpo, 2000; Shi *et al.*, 2008; Cordano *et al.*, 2010).

SMEs often lack human resources, for example few knowledge workers with expertise on RoHS compliance, as well as financial resources to initiate expensive EMSs (Lee, 2009; Adams *et al.*, 2012). Kim (2011) compares the project management maturity levels between SMEs and large enterprises in Korea. The results of his study

clearly show the different project management capabilities of the firms in different scales. Due to lack of human resources and internal innovation capability, SMEs experience difficulties in achieving satisfactory performance in their projects (i.e. implementing quality management or SCM systems). For example, large firms were achieving excellent outcomes in all knowledge areas of project management maturity, such as time management, cost management, quality management, risk management, and so on. Certainly, some medium-sized firms have developed good infrastructure with high levels of expertise and resources to cope with external pressures and changes in the market. However, as we addressed earlier, a number of SMEs are struggling with implementing new requirements of their buying firms mainly because of lack of knowledge, expertise, and financial and human resources.

SMEs often have inadequate proactive environmental strategy, environmental awareness, and environmental management techniques (Shearlock *et al.*, 2000; Sarkis and Dijkshoorn, 2007). They are often ineffective in dealing with environmental management issues. Thus, these SME suppliers can obstruct the progress of customer firms' GSCM practices (Lee and Klassen, 2008).

Hypotheses development

Figure 1 outlines the theoretical model that guides this research. We propose a mediated model where implementation of GSCM practices has a positive influence on the firm's business performance (BP) directly and through firm's operational efficiency (OE), relational efficiency (RE), and employee job satisfaction (SAT). Definitions of the constructs employed in this study are provided in Table I.

Implementation of GSCM practices and business performance

Madsen and Ulhøi (2003) argue that corporate adoption of environmental management is to harmonize an environmental strategy with other strategic issues such as corporate goals and product positioning. They also state that the result of proactive pollution prevention programs could actually reduce production cost and improve product value or the image of the company. Thus, effective environmental programs can help make the firm more competitive in the market (Porter and van der Linde, 1995). Moneva and Ortas (2010) also discovered that environmental performance has

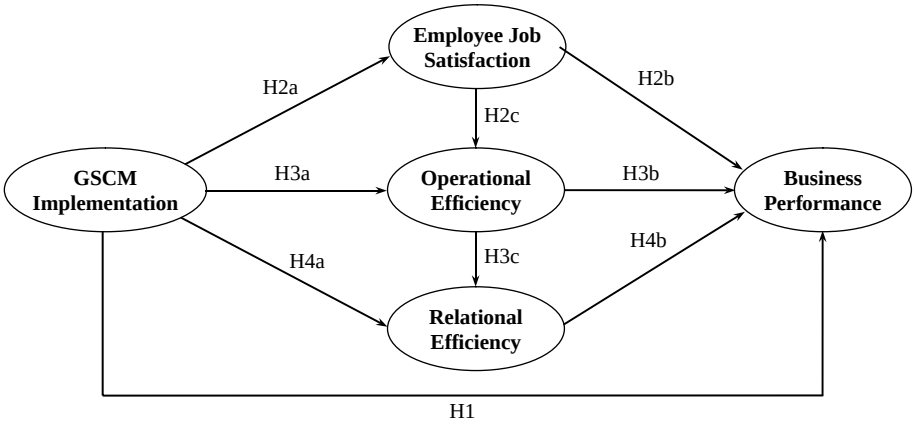


Figure 1.
The research model

Construct	Definition	Reference
GSCM practice implementation	Adoption of environmentally friendly SCM practices including internal environmental management, green purchasing, cooperation with customers, and eco-design for developing corporate and operational strategies for the firm's environmental sustainability	Zhu *et al.* (2008)
Employee job satisfaction	The feeling that employees have on their jobs related to the relationship with their supervisors and working environment, which could lead to better performance outcomes	Homburg and Stock (2004), Zhou *et al.* (2008)
Operational efficiency	The ability of supplying firms to reduce costs and cycle time, improve product quality, and create greater customer value	Rusinko (2007), Zhu *et al.* (2008), Zacharia *et al.* (2009)
Relational efficiency	The ability of supplying firms to increase transparency and openness in the business processes working jointly with buyers so that suppliers can build trust and credibility in the relationship with buyers	Pfeffer and Salancik (1978), Zacharia *et al.* (2009)
Business performance	Financial and non-financial performance of the organization as a result of the implementation of GSCM practices as well as improvement in operational/ relational efficiency and employee job satisfaction	Zhu *et al.* (2008), Zacharia *et al.* (2009)

Table I.
Construct definitions

a positive correlation with financial performance of the firm. In their event study, the authors analyzed corporate environmental performance (CEP) in 2004 and corporate financial performance (CFP) in the 2005-2007 periods. Then, they tested the three relationships between:

(1) CEP in 2004 and CFP in 2005;

(2) CEP in 2004 and CFP in 2006; and

(3) CEP in 2004 and CFP in 2007.

The results of the tests in this research present that CEP enhances firms' internal efficiency and their CFP in the future periods.

Khanna and Anton (2002) believe that corporate environmental management is a self-regulatory business approach not only to protect the environment, but also to strategically integrate environmental considerations into corporate strategic decisions. This study is based on the premise that a major part of the corporate environmental management initiative is to implement green management systems, such as ISO 14001 or the Eco-Management and Audit Scheme (EMAS). The test results of Khanna and Anton (2002) support the importance of proactive environmental management that is actually a cost saving proposition in the long-run (Klassen and Whybark, 1999; Madsen and Ulhøi, 2003). Otherwise, compliance with restrictions results in high costs and public pressures on the corporation.

Companies adopting environmental management or GSCM are viewed as socially responsible firms (Borger and Kruglianskas, 2006; Montiel, 2008; Cruz and Pedrozo, 2009). Many studies have asserted that corporate social responsibility (CSR) and the firm's business performance are positively related. According to McGuire *et al.* (1988), CSR is positively related to a firm's business performance, such as stock market returns

and accounting-based measures. That result may be because socially responsible corporations can stand in a better economic position than socially irresponsible ones. Thus, the following hypothesis is proposed:

H1. The implementation of GSCM practices is positively related to the business performance at the firm level.

Employee job satisfaction, GSCM practices, operational efficiency, and business performance

It is an argument consistently made by a number of prior studies that one of the results of CSR is improved employees' goodwill and job satisfaction (McGuire *et al.*, 1988; Valentine and Fleischman, 2008). In addition, according to Lee and Chang (2008), innovative spirit in the organizational culture and group-oriented teamwork show a positive impact on job satisfaction of the employees. It is expected that all personnel in the production lines would feel safer and be more satisfied with their operations and the working environment when unsafe toxic materials are removed from the production process. It may be true that both GSCM and TQM practice implementation create a similar atmosphere in the workplace and result in similar organizational outcomes. Subsequently, GSCM practice implementation and employee satisfaction may have a similar positive relationship as that observed between TQM practice implementation and employee job satisfaction (Jun *et al.*, 2006).

Job satisfaction is a measure of the degree of employee pleasure that leads to better task performance (Edwards *et al.*, 2008). Harrison *et al.* (2006) found that job attitude, including job satisfaction and organizational commitment, is a strong precursor of employees' organizational behavior and performance based on meta-analysis. In addition, Patterson *et al.* (2004) examined the connection between the company climate and organizational performance, and revealed an indirect relationship between them. They tested how the company climate, measured by employees' perceptions concerning the organization's policies and practices, is associated with productivity. Their study results show that the link between the company climate and productivity is mediated by the workers' job satisfaction. Thus, the following three hypotheses are suggested:

H2a. The implementation of GSCM practices is positively related to employee job satisfaction.

H2b. Employee job satisfaction is positively related to business performance at the firm level.

H2c. Employee job satisfaction is positively related to the operational efficiency of the firm that implemented GSCM practices.

Operational efficiency, GSCM practices, relational efficiency, and business performance

RDT conceptualizes the effects of environments on organizations using external and internal perspectives (Pfeffer and Salancik, 1978). The internal perspective is associated with organizational efficiency that accounts for the "internal evaluation of the amount of resources consumed in the process of doing this activity" (Pfeffer and Salancik, 1978). Leading global firms, such as Samsung and LG Electronics, claim that they have executed their operations more effectively and efficiently in all dimensions

since they implemented GSCM practices (Lee, 2007). For firms that successfully implement and utilize GSCM practices, the main benefit is the development of internal operations that assist in improving decision-making processes for cleaner production (Lee, 2011). Lippman (2001) advises that based on his interviews with small supplying firms, organizations experience increases in their operational outcomes, such as reduction in cycle time and cost, and in a few cases increases in sales by adopting GSCM practices. Lee (2009) conducted case studies on green management of SMEs. The outcomes of his studies present that systematic green management helps reduce production costs by enhancing operational efficiencies such as less water consumption, reduced waste water generation and saved material usage.

Inter-organizational relationships may be built based on economic benefits which are related to trust-based relationships (Ireland and Webb, 2007). That is the reason why buying firms emphasize the excellence in partner firms' operational outcomes or performance. In this regard, Zacharia *et al.* (2009) claim that a firm can gain more trust and credibility from a collaborating counterpart when it proves its excellence in its operations, and the relationship effectiveness will be enhanced when the partner firm continuously accomplishes success in their joint efforts. Hence, relational efficiency can also be affected by operational efficiency (Zacharia *et al.*, 2009). Based on the discussion here, the following three hypotheses are proposed:

H3a. The implementation of GSCM practices is positively related to the operational efficiency of the firm.

H3b. Operational efficiency is positively related to business performance at the firm level.

H3c. The improved supplier's operational efficiency has a positive impact on the relational efficiency between the supplier and the large customer firm.

Relational efficiency, GSCM practices, and business performance

Manuj and Mentzer (2008) argue that risks in the global supply chain occur as the extended supply chain hides a number of potential threats. Many of the problems existed in the original supply chain would remain in the global supply chain and those unresolved issues involving product quality, inventory control, and buyer-supplier trust could be amplified by new risk factors – distance, language, and cultural differences besides supply chain disruptions by unforeseen natural disasters. In the resource dependence perspective, buying firms manage to secure the flow of inputs to their organizations by forming stable, long lasting relationships with international suppliers (Pfeffer and Salancik, 1978; Kaufmann and Carter, 2006). Since firms become reliant on partner firms for needed inputs, establishing good inter-organizational relationships has become the key to minimizing such environmental uncertainty (Pfeffer and Salancik, 1978; Ketchen and Hult, 2007).

According to RDT, if an organization gains successful outcomes from a relationship, the organization more highly values the relationship (Pfeffer and Salancik, 1978). In this regard, we can expect that the more the buying firm and suppliers make collaborative efforts in implementing GSCM practices, the higher the levels of trust, credibility, and relationship effectiveness between the partners (Lamming and Hampson, 1996; Simpson *et al.*, 2007; Ryu *et al.*, 2009; Zacharia *et al.*, 2009). In fact, Lippman's (2001) study shows

that corporate customers demand high levels of environmental performance from their suppliers. Hence, they mandate the suppliers to use environmental regulatory programs.

Prior studies suggest that inter-organizational trust in supply chains should be a "prerequisite" to the success of inter-organizational collaboration (Sahay, 2003; Ryu *et al.*, 2009; Fawcett *et al.*, 2004). Higher levels of inter-organizational trust in supply chains help establish integrated goals and plans smoothly, improve product quality, and create greater customer value (Monczka *et al.*, 1998; Wong *et al.*, 2005). Similarly, it is suggested that joint efforts between manufacturers and suppliers in various areas, such as developing cleaner technology, ecological product/process design, and integrated information systems between the two parties, create the best results. Lamming and Hampson (1996) assert that this collaboration would offer "better market opportunities for the suppliers to embed its business in the customer's value chain." Moreover, studies show that well established, long-term relationship between buyer and supplier firms helps suppliers improve their performance (Kaufmann and Carter, 2006; Liao, 2010; Rhee *et al.*, 2011). Thus, the following two hypotheses are developed:

H4a. The implementation of GSCM practices has a positive influence on the relational efficiency between the supplier and the large customer firm.

H4b. Relational efficiency between the supplier and the large customer firm is positively related to the supplier's business performance.

Mediation effects

As discussed earlier, a number of studies showed that suppliers can increase the levels of credibility and effective working relationship with their buyer firms by implementing GSCM practices (Lamming and Hampson, 1996; Simpson *et al.*, 2007; Ryu *et al.*, 2009; Zacharia *et al.*, 2009). In addition, Liao (2010) asserts that trust-based inter-organizational relationship is positively associated with the firm's performance. We expect that operational efficiency is also to be influenced by newly implemented GSCM practices. Zacharia *et al.* (2009) examine whether business performance is significantly correlated with both operational and relational outcomes. Their results show that both have statistically significant positive relationships. Even though there may be many other factors that affect an organization's business performance, in the context of supply chain collaboration, these empirical tests are important. Previous studies also present that there is a link between business performance and employee job satisfaction. Zhou *et al.* (2008) offer evidence in Chinese manufacturing companies that firm performance has a positive correlation with employee job satisfaction. Thus, we posit the following hypothesis:

H5. Employee job satisfaction and operational efficiency in the supplier firm, and relational efficiency between the supplier and the large buyer firm mediate the relationship between GSCM practice implementation and the supplier's business performance.

Research methodology

Questionnaire development

Zhu and Sarkis (2006) developed and tested a measurement model for GSCM practice implementation. They found five underlying constructs which show the dimensions of GSCM practices. In this study, however, only four dimensions of GSCM practices – internal environmental management (IEM), green purchasing (GP), cooperation with

customers (CC), and eco-design (ECO) – are selected focusing on the following three aspects of GSCM practice adoption:

(1) internal environmental management such as top management support, environmental compliance programs, inter-departmental cooperation for environmental improvements;

(2) external relationships such as green purchasing and customer cooperation over environmental concerns; and

(3) broader-based interactions involving green (or eco-) design practices, which would incorporate cooperative design and delivery of those designs.

We adopted these measurement items of Zhu and Sarkis (2006), with modifications for the "internal environmental management" and "green purchasing" constructs. For "cooperation with customers" and "eco-design", we utilize additional items that are found in other studies (Homburg and Stock, 2004; Chen, 2005; Matos and Hall, 2007; Hsu and Hu, 2008; Paulraj *et al.*, 2008; Zacharia *et al.*, 2009; Zhou *et al.*, 2008). Manipulation of the measurement variables is presented in the Appendix. For the measurement items, we used a five-point scale (1 – not considering it, 2 – planning to consider, 3 – considering it currently, 4 – initiating implementation, and 5 – currently implementing). In assessing other variables in the structural equation model, questions were on another five-point scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree).

In developing the questionnaire, the double translation protocol was used. The questionnaire was developed in English first and then was translated into Korean. After the translation, the questionnaire was presented to a panel of experts from academia as well as those in the electronics industry to solicit their comments and suggestions regarding the survey items. Then, the Korean version was translated back into English. The two English versions did not have any major difference.

Population and data sources

The population of interest for this study is operations/supply chain managers of small- and medium-sized electronics firms in Korea. The operations/supply chain managers are chosen because:

- the study is about a major activity of SCM; and
- they are in "a critical position to influence the size of the overall environmental footprint of a company" (Walton *et al.*, 1998).

The population has three distinct characteristics that impact the generalizability of this study and as a result will be addressed in the remainder of this section:

(1) small- and medium-sized suppliers;

(2) only in the electronics industry; and

(3) only Korean firms.

The reason that we pay attention to small- and medium-sized suppliers is that their lack of environmental management capability can have a negative impact on financial performance and brand image of the customer firm, as they represent the "invisible link" in supply chains (Shearlock *et al.*, 2000; Sarkis and Dijkshoorn, 2007; Lee and Klassen, 2008).

There are two reasons for selecting the electronics industry. First, this industry is changing rapidly due to globalization and technological advances. Consequently, environmental issues and concerns develop fast, and many significant regulatory acts have been and will be enforced globally for this industry. Second, we took the sample only from the electronics industry in order to control for any potential confounding factors, such as variations in market conditions or environmental regulations.

Lastly, the reason that Korean firms were chosen is that Korea is one of the emerging developed nations with the government's strong environmental enforcement. Also Korean electronics firms such as Samsung and LG Electronics are global leaders in the industry (Hsu and Hu, 2008; Bicheno, 2009; Maisto, 2010). Their products are also popular in European countries where the strict environmental regulations are enforced.

Sample selection

The questionnaire was administered to a subset of the population of interest – operations/supply chain managers of small- and medium-sized electronics companies in Korea. The actual survey was conducted in cooperation with a Korean research consulting firm. The list of the SMEs in the electronics industry was provided from the Korea Investor Service (KIS), which is the first credit rating agency in Korea. The survey team of the consulting firm first called the contact numbers of 756 companies, with more than 20 employees and less than 500, to ask whether they were aware of any environmental systems or programs. Then, the questionnaire was sent to the operations/supply chain managers of 223 SME suppliers that were willing to participate in the survey and all of them mailed the questionnaires back to the researchers. If any omitted questions were found, the survey team called the manager to complete the questionnaire. The surveys were conducted from May 10, 2010 to May 28, 2010.

Results

Responding firms' characteristics

Table II represents the characteristics of the responding companies as well as respondents' job titles and work experience. Respondents' job titles ranged from the employee in charge of GSCM to the top executive. Middle (51.1 percent) and senior (27.8 percent) managers were the most frequently reported job titles in charge of GSCM. This result indicate that GSCM practices often require the supervision of higher-level management team and also demonstrate that these SME supplier firms strive to succeed in implementing GSCM practices. In addition, majority of the respondents (83.9 percent) have worked less than ten years. One thing that needs to be pointed out is that the question on the work experience might have been confusing to the respondents as to whether it asked for work experience in the industry or only in the current company. Hence, it is possible that many of the respondents with work experience less than five years might actually have had longer careers in the industry.

All responding firms were classified as small- and medium-sized companies. Here is the distribution: 91 firms (40.8 percent) with less than 50 employees, 65 firms (29.2 percent) with 50-99 employees, 43 firms (19.3 percent) with 100-199 employees, and 24 firms (11.8 percent) with 200-500 employees. Regarding industry classifications of their buyer firms (multiple answers were allowed), 238 (92 percent) firms answered that their buyer firms were in the electronics industry, 11 (5 percent) in telecommunications, nine (3 percent) in automotive, and only one (0.4 percent) was in the retail industry.

	Frequency	%
A. Respondents' job title		
Employee in charge	33	14.8
Middle manager	114	51.1
Senior executive	62	27.8
Top executive	14	6.3
Total	223	100.0
B. Respondents' work experience (years)		
Less than 5	123	55.2
5-10	64	28.7
11-15	27	12.1
More than 15	9	4.0
Total	223	100.0
C. Firm size (no. of employees)		
Less than 50	91	40.8
50-100	65	29.2
101-200	43	19.3
201-300	10	4.5
301-400	6	2.7
401-500	8	3.5
Total	223	100.0
D. Industry classification of the buying firms (multiple answers)		
Electronics	238	
Telecommunication	11	
Automobile	9	
Retail	1	
Total	223	100.0
E. Firm's primary business goal in supply chain		
First-tier supplier to major firms	148	66.4
Second-tier supplier	64	28.7
Supplier to government	10	4.5
Other	1	0.4
Total	223	100.0

Table II.
Characteristics of responding firms

SME suppliers can be classified based on their primary business goals in the supply chain. It was reported that 148 firms (66.4 percent) were "suppliers to major buying companies", 64 firms (28.7 percent) "second-tier suppliers", ten firms (4.5 percent) answered that they "supply to government agencies" and one firm (0.4 percent) checked "others" (Table III).

Adoption of EMSs

The survey asked the operations/supply chain managers several questions related to the environmental management: first, "are you aware of such EMSs and programs?" As shown in Table IV, most of them (98.7 percent) knew what ISO 14000 series were and about one-half of the respondents recognized the electronic product environmental assessment tool (45.3 percent) and total quality environmental management (48.4 percent). However, less than 40 percent of the managers have heard about other programs such as the European EMAS (30.0 percent), EU eco-label award scheme (24.2 percent), environment, health and safety (EHS) programs (36.3 percent), and life cycle assessment (LCA) (32.3 percent).

EMSs	Awareness Yes	Awareness No	Adoption Yes	Adoption No
ISO 14000 series	220 (98.7)	3 (1.3)	215 (96.4)	8 (3.6)
Electronic product environmental assessment tool	101 (45.3)	122 (54.7)	42 (18.8)	181 (81.2)
European EMAS	67 (30.0)	156 (70.0)	20 (9.0)	203 (91.0)
EU eco-label award scheme	54 (24.2)	169 (75.8)	14 (6.3)	209 (93.7)
EHS programmers	81 (36.3)	142 (63.7)	35 (15.7)	188 (84.3)
LCA	72 (32.3)	151 (67.7)	24 (10.8)	199 (89.2)
Total quality environmental management	108 (48.4)	115 (51.6)	60 (26.9)	163 (73.1)

Note: Percentage values are in parenthesis

Table III.
Awareness and adoption of EMSs

Factors	IEM	GP	CC	ECO	ES	OE	RE	BP
Internal environmental management (IEM)	1.00							
Green purchasing (GP)	0.58	1.00						
Cooperation with customers (CC)	0.52	0.65	1.00					
Eco-design (ECO)	0.53	0.47	0.44	1.00				
Employee job satisfaction (ES)	0.62	0.47	0.42	0.43	1.00			
Operational efficiency (OE)	0.49	0.31	0.26	0.40	0.35	1.00		
Relational efficiency (RE)	0.56	0.44	0.40	0.33	0.46	0.65	1.00	
Business performance (BP)	0.46	0.32	0.35	0.44	0.48	0.66	0.62	1.00

Table IV.
Correlation between theoretical constructs

The second question was, "which EMS has your company already adopted?" The most popularly used one was ISO 14000 series – 215 out of 223 firms (96.4 percent) have implemented it. Yet, the survey result shows that there was limited use of other than ISO 14000 series from the major buying firms in the Korean electronics industry. Only four firms mentioned that they built a system to comply with the EU's RoHS Directive (Table V).

Analysis of reliability and validity

We tested the measurement properties of the constructs using reliability and item-to-total correlation analysis, followed by confirmatory factor analysis (CFA). Based on the covariance matrix for the variables, the standardized factor loadings and *t*-values were obtained. As shown in Table VI, both standardized loadings (>0.60) and *t*-values ($p < 0.01$) for the individual paths were significantly related to their underlying theoretical constructs. In addition, all of the average variance extracted (AVE) estimates of constructs were greater than the cutoff point (0.5) (Fornell and Larcker, 1981). These tests, thus, exhibit convergence validity.

We also compared the squared correlation coefficients between two latent constructs to their AVE estimates (Fornell and Larcker, 1981). According to this test, discriminant validity exists if the items share more common variance with their respective construct than any variance the construct shares with other constructs. Thus, the squared correlation coefficient between each pair of constructs should be less than the AVE estimates for each individual construct. Comparing the correlation coefficients given in Table IV with the AVE estimates reported in Table V, all of the squared correlations were smaller than the AVE for each individual construct.

Factors	Item no.	Mean	SD	Item-to-total correlation	Cronbach's α	AVE	CR
Internal environmental management	IEM1	3.84	0.837	0.642	0.882	0.586	0.875
	IEM2	3.37	0.986	0.584			
	IEM3	3.51	0.981	0.784			
	IEM4	3.72	0.985	0.790			
	IEM5	3.66	0.991	0.799			
Green purchasing	GP1	3.65	0.970	0.747	0.891	0.678	0.893
	GP2	3.75	1.034	0.714			
	GP3	3.69	0.958	0.750			
	GP4	3.69	0.954	0.834			
Cooperation with customers	CC1	3.68	1.062	0.719	0.919	0.748	0.922
	CC2	3.75	1.022	0.851			
	CC3	3.74	1.010	0.833			
	CC4	3.69	1.009	0.858			
Eco-design	ECO1	3.88	1.123	0.653	0.858	0.551	0.844
	ECO2	3.28	1.202	0.731			
	ECO3	3.42	1.201	0.666			
	ECO4	4.04	1.067	0.616			
	ECO5	3.48	1.126	0.704			
Employee job satisfaction	ES1	3.37	0.771	0.704	0.908	0.667	0.909
	ES2	3.55	0.836	0.757			
	ES3	3.39	0.797	0.810			
	ES4	3.36	0.804	0.774			
	ES5	3.48	0.740	0.800			
Operational efficiency	OE1	2.89	1.044	0.833	0.937	0.709	0.936
	OE2	2.90	1.088	0.816			
	OE3	3.18	1.077	0.881			
	OE4	3.27	1.070	0.812			
	OE5	2.88	1.052	0.834			
	OE6	3.44	1.011	0.702			
Relational efficiency	RE1	3.47	1.043	0.887	0.971	0.833	0.968
	RE2	3.48	1.026	0.888			
	RE3	3.41	1.043	0.887			
	RE4	3.42	1.027	0.915			
	RE5	3.44	1.011	0.927			
	RE6	3.45	1.021	0.926			
Business performance	BP1	3.06	0.980	0.745	0.914	0.733	0.916
	BP2	3.30	0.976	0.752			
	BP3	3.12	1.042	0.870			
	BP4	3.11	0.999	0.809			

Table V.
Summary of measurement results of reliability and validity

Therefore, these results collectively provided evidence of discriminant validity among the theoretical constructs.

Reliability estimation was left for last because in the absence of a valid construct, reliability would not be meaningful (Koufteros, 1999). Item-to-total correlation analysis results provided in Table V suggest a reasonable fit of the latent factors to the data collected. Cronbach's α values for all factors were greater than 0.85, which ensure the internal consistency and validity of the constructs as they were well above the suggested value of 0.70 (Nunnally and Vernstein, 1994). The item factor loadings were

Factors	Item no.	Standardized loading	*t*-value
Internal environmental management	IEM1	0.711	18.439
	IEM2	0.645	14.628
	IEM3	0.860	33.569
	IEM4	0.790	24.759
	IEM5	0.804	26.399
Green purchasing	GP1	0.788	26.355
	GP2	0.742	21.756
	GP3	0.833	34.200
	GP4	0.920	53.205
Cooperation with customers	CC1	0.749	23.318
	CC2	0.892	50.886
	CC3	0.898	54.395
	CC4	0.912	59.603
Eco-design	ECO1	0.710	17.605
	ECO2	0.710	17.583
	ECO3	0.625	12.921
	ECO4	0.713	17.734
	ECO5	0.839	27.458
Employee job satisfaction	ES1	0.725	20.453
	ES2	0.788	26.788
	ES3	0.860	39.105
	ES4	0.844	35.709
	ES5	0.859	38.622
Operational efficiency	OE1	0.830	34.352
	OE2	0.815	32.149
	OE3	0.921	66.466
	OE4	0.860	42.304
	OE5	0.852	39.331
	OE6	0.765	25.138
Relational efficiency	RE1	0.853	44.527
	RE2	0.855	45.329
	RE3	0.873	51.599
	RE4	0.948	123.304
	RE5	0.972	195.882
	RE6	0.967	174.995
Business performance	BP1	0.761	24.916
	BP2	0.771	26.057
	BP3	0.941	81.295
	BP4	0.934	76.874

Table VI. Measurement model results

all acceptable, i.e. all were much greater than 0.5 (Nunnally and Vernstein, 1994). Alternatively, composite reliability (CR) scores were computed to assess construct reliability. According to Koufteros (1999), a CR greater than 0.80 would imply that the variance captured by the factor is significantly more than the variance indicated by the error components. As reported in Table V, all factors showed CRs greater than 0.84, which ensure the construct reliability of all constructs.

Goodness-of-fit of the research model

Dimensionality of the GSCM practice implementation scale. Zhu *et al.* (2008) developed both first- and second-order measurement models for GSCM practice implementation.

We examined the two measurement models and adopted them with some modification as discussed previously. The goodness-of-fit indices of the first-order model were within the commonly accepted limits. CFI = 0.958 (≥ 0.90) and SRMR = 0.050 (≤ 0.06) satisfied the cutoff points (Bentler, 1988). χ^2 statistics of 242.481 at 128 degrees of freedom implies that $\chi^2/df = 1.89$, which is less than the benchmark of 2.0 (Koufteros and Marcoulides, 2006). Thus, as presented in Table VII and Figure 2, the test results confirmed the unidimensionality of these scales, i.e. items constituting the GSCM practice implementation represent the same theoretical construct.

To examine whether or not there is internal fit among the GSCM practices, we performed CFA including GSCM practice implementation as a second-order latent factor underlying the first-order latent variables corresponding to the GSCM practice implementation dimensions. As Figure 3 shows, all underlying constructs of GSCM practice implementation were well correlated and governed by the higher-order factor. In addition, as summarized in Table IX, the values for the model fit indices in this higher-order model also showed that the model fit data very well. χ^2 statistics of 248.178 at 130 degrees of freedom implies that $\chi^2/df = 1.91$, CFI = 0.957 and SRMR = 0.053 satisfied the cutoff points as well (Bentler, 1988; Koufteros and Marcoulides, 2006).

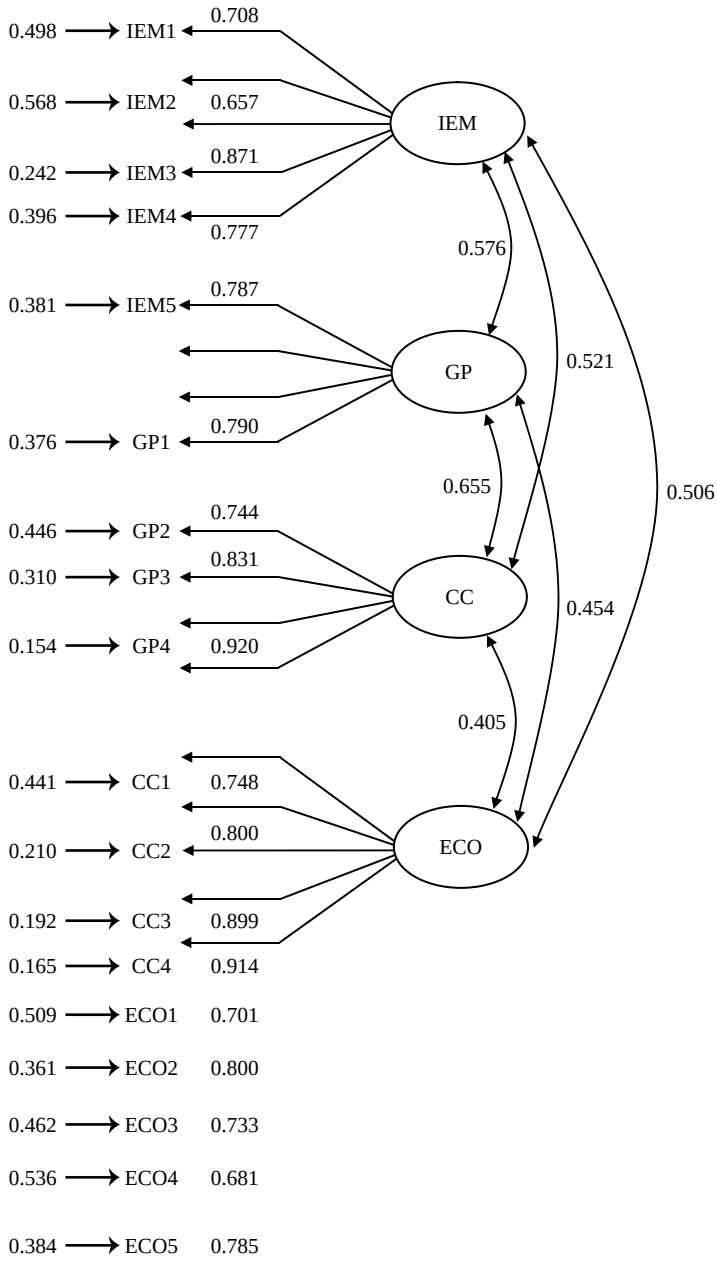
As such, this study established the validity and reliability of the measurement scale in both the first- and second-order models as Zhu *et al.*'s (2008) empirical study did. Before deciding which one to use for the empirical tests, the χ^2 statistics of both models were compared to evaluate the efficacy of the two (Marsh and Hocevar, 1985).

The χ^2 test is usually used to confirm whether the difference between the expected and the observed frequencies in one or more categories is a real, statistically significant difference (Sirkin, 1999). The χ^2 test result in this study showed that there was no statistically significant difference between the two models because the difference between the χ^2 statistics of both first- and second-order models was 5.697, smaller than 5.991 where the degree of freedom is 2 at $p \leq 0.05$. Beltrán-Martín *et al.* (2008) showed that covariation among the first-order factors and the observable variable is fully explained by their regression onto the second-order factor. Therefore, in this study we used the higher-order measurement model for testing the hypothesized structural equation model.

Dimensionality of the scales of employee job satisfaction, operational efficiency, relational efficiency, and business performance. We verified the unidimensionality of all four constructs: employee job satisfaction, operational efficiency, relational efficiency, and business performance. As reported in Table VIII and Figure 4, all fit indices were satisfied *vis-á-vis* cutoff points. CFIs of all four constructs ranged from 0.957 to 0.994, and SRMRs were all less than 0.60. Regarding χ^2 statistics, even though all χ^2/df ratios of these four constructs were greater than 2.0, Medsker *et al.* (1994) suggested that χ^2/df ratios less than 10 can be interpreted as indicating a good fit to the data.

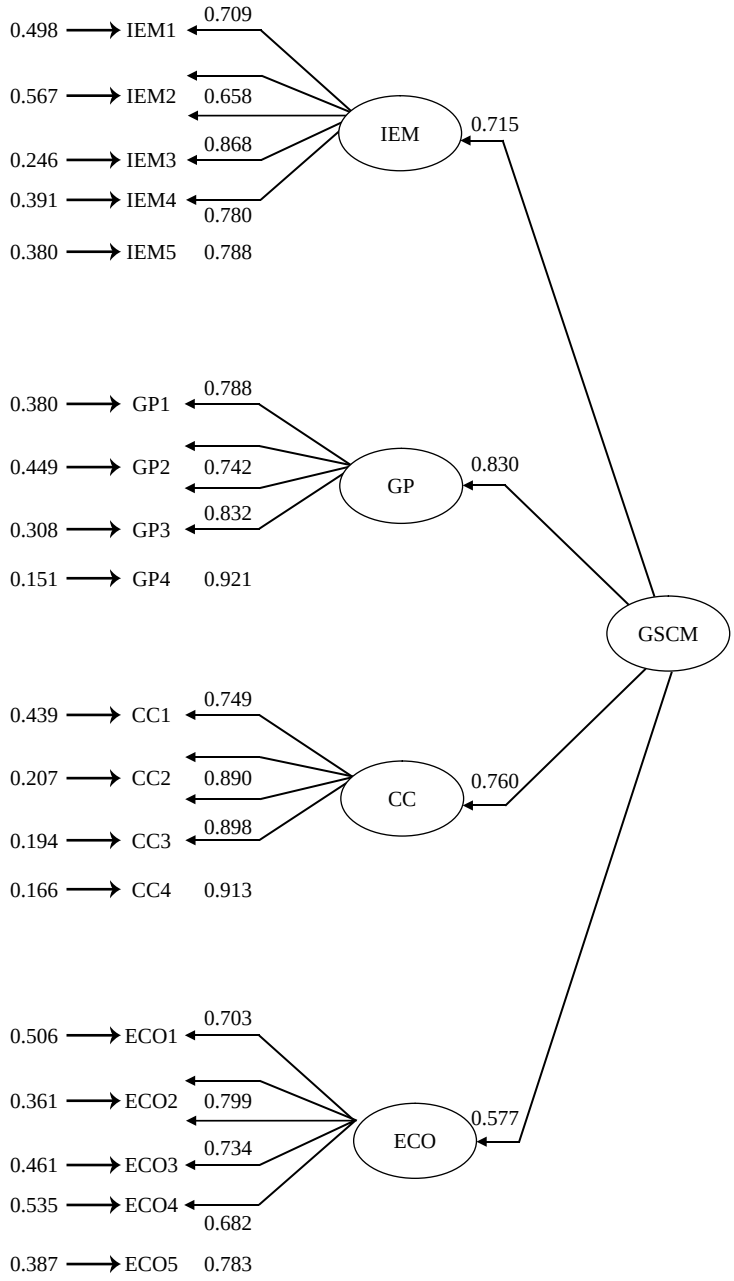
Table VII. Statistics of first- and second-order models

Model statistics	First-order	Second-order
χ^2	242.481	248.178
df	128	130
χ^2/df	1.89	1.91
CFI	0.958	0.957
SRMR	0.050	0.053



Notes: Fit indices: x^2 (128) = 242.481 ($p < 0.001$); x^2/df = 1.89; CFI = 0.958; SRMA = 0.050

Figure 2.
First-order factor measurement model for GSCM practice implementation



Notes: Fit indices: x^2 (130) = 248.178 ($p < 0.001$); x^2/df = 1.91; CFI = 0.957; SRMA = 0.053

Figure 3.
Second-order factor measurement model for GSCM practice implementation

Taken all together, the results from the instrument development process showed that the theoretical constructs exhibit good psychometric properties.

Hypotheses testing

Direct effects

The results of the structural model are shown in Table IX and Figure 5. All fit indices were indicative of a decent fitting model. The most anticipated finding in this study, a statistically significant direct link between GSCM practice implementation and business performance, did not materialize, not supporting *H1* (b = 0.084; $t = 0.782$; $p = 0.484$). This result leads to further discussion on indirect or mediating effects in the

Model	χ^2	df	p	χ^2/df	CFI	SRMR
GSCM practice implementation first-order	242.481	128	0.000	1.89	0.958	0.050
GSCM practice implementation second-order	248.178	130	0.000	1.91	0.957	0.053
Employee job satisfaction scale	25.772	4	0.000	6.44	0.971	0.025
Operational efficiency scale	20.059	6	0.003	3.33	0.988	0.019
Relational efficiency scale	16.816	6	0.010	2.80	0.994	0.007
Business performance scale	19.695	2	0.000	9.85	0.975	0.025

Table VIII. Fit indices for the confirmatory factor analysis

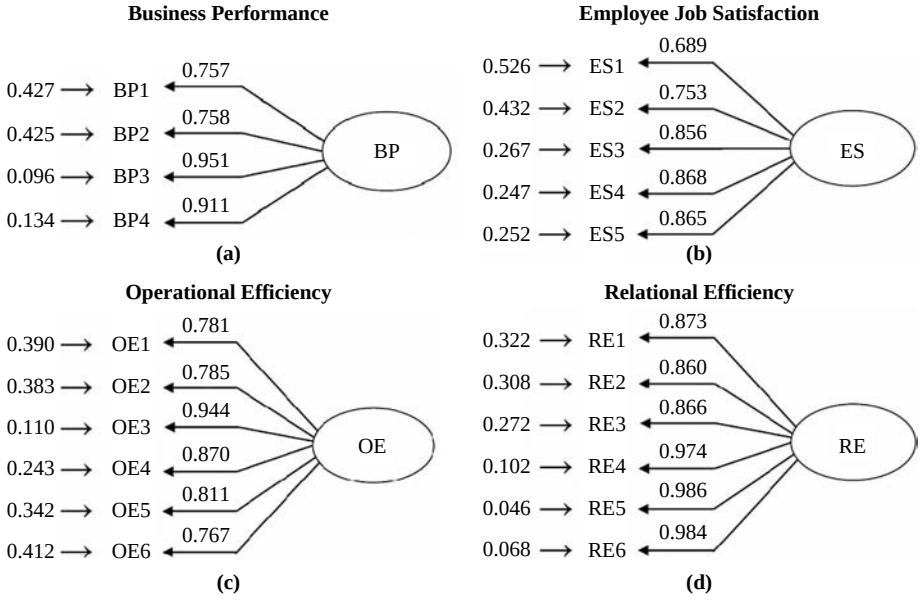


Figure 4. Confirmatory factor analyses of employees' job satisfaction, operational efficiency, relational efficiency, and business performance

Notes: Fit indices: (a) x^2 (2) = 19.695 ($p < 0.001$); x^2/df = 9.85; CFI = 0.975; SRMA = 0.025; (b) x^2 (4) = 25.772 ($p < 0.001$); x^2 /df = 6.44; CFI = 0.971; SRMA = 0.025; (c) x^2(6) = 20.059 ($p < 0.001$); x^2 df = 3.33; CFI = 0.988; SRMA = 0.019; (d) x^2(6) = 16.816 ($p < 0.001$); x^2 /df = 2.80; CFI = 0.994; SRMA =0.007

Path (from-to)	Direct effects (*t*-value)	Indirect effect (*t*-value)	Hypotheses test results
H1. GSCM implementation → business performance (direct)	0.084 (0.782)		Not supported
H2a. GSCM implementation → employee job satisfaction	0.720 (15.353)*		Supported
H2b. Employee job satisfaction → business performance	0.161 (1.877)		Not supported
H2c. Employee job satisfaction → operational efficiency	0.024 (0.204)		Not supported
H3a. GSCM implementation → operational efficiency	0.444 (3.688)*		Supported
H3b. Operational efficiency → business performance	0.423 (6.578)*		Supported
H3c. Operational efficiency → relational efficiency	0.447 (7.886)*		Supported
H4a. GSCM implementation → relational efficiency	0.410 (6.858)*		Supported
H4b. Relational efficiency → business performance	0.233 (3.022)*		Supported
H5. GSCM implementation → business performance (indirect)		0.455 (5.407)*	Supported

Table IX.
Results of path analyses and hypotheses tests

Notes: Significant at: * $p < 0.01$; fit indices: $\chi^2 = 1615.675$ (df = 689), χ^2/df = 2.345, CFI = 0.887, SRMR = 0.071

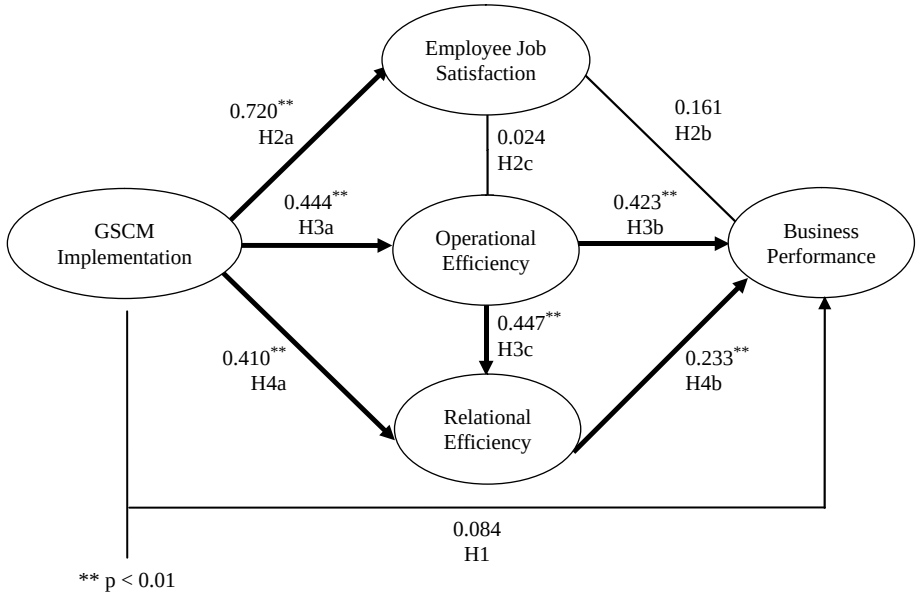


Figure 5.
Hypothesized structural model results

succeeding section. *H2-H4*, linking GSCM practice implementation and the three constructs (employee job satisfaction, operational and relational efficiencies), all showed positive and statistically significant results ($p < 0.01$). Specifically, the paths from the implementation of GSCM practices to the following showed significant positive results:

(1) employee job satisfaction (b = 0.72; $t = 15.353$; $p < 0.01$);

(2) operational efficiency (b = 0.444; $t = 3.688$; $p < 0.01$); and

(3) relational efficiency (b = 0.41; $t = 6.858$; $p < 0.01$).

H5 and *H7*, the relationships of employee job satisfaction – operational efficiency and employee job satisfaction – business performance, were not supported in this study: employee job satisfaction on operational efficiency (*H5*) with b = 0.024; $t = 0.204$; $p = 0.839$ and employee job satisfaction on business performance (*H7*) with b = 0.161; $t = 1.877$; $p = 0.061$. That is, even though the implementation of GSCM practices has a positive influence on employee job satisfaction (*H2*), job satisfaction may not have a statistically significant direct impact on operational outcome and/or business performance.

Operational efficiency is purported to be conducive to relational efficiency between the buying firm and SME suppliers. *H6* states that the improved operational efficiency in the supplier has a positive impact on the relational efficiency between the supplier and the large customer firm. The test result indicated that the two factors have a positive, statistically significant relationship with a *t*-value of 7.886 at $p < 0.01$. Hence, in addition to having a direct effect from GSCM practice implementation (*H4*), relational efficiency also has an indirect effect via operational efficiency (*H6*). It was posited that both improved operational efficiency of the supplier (*H8*) and relational efficiency between the supplier and its customer company (*H9*) would positively affect the supplier's business performance. Both effects as hypothesized by *H8* and *H9* were statistically significant: *H8* (b = 0.423; $t = 6.578$, $p < 0.01$) and *H9* (b = 0.233; $t = 3.022$; $p < 0.01$).

Mediation analysis

To examine the mediating effects between GSCM practice implementation and business performance, structural equation modeling (SEM) was used following the commonly used Baron and Kenny (1986) method. In the previous section, the direct link between GSCM practice implementation and business performance was found to be non-significant. Meanwhile, the results of hypotheses tests presented that the initial variable GSCM practice implementation was positively correlated with all three mediators: employee job satisfaction, operational efficiency, and relational efficiency. Then, the test results showed that two mediators except employee job satisfaction had direct, positive and statistically significant relationships with the outcome variable, business performance.

As proposed by *H10* (employee job satisfaction, supplier's operational efficiency, relational efficiency between the supplier and the large customer firm mediating the relationship between GSCM practice implementation and the supplier's business performance) was estimated and supported (b = 0.455; $t = 5.407$; $p < 0.01$). This means, firms' business performance will improve when they accomplish operational and relational efficiencies as well as secure employee job satisfaction after adopting GSCM practices. More specifically, the results showed that this mediating effect (b = 0.455) were more than five times greater than the direct effect (b = 0.084). The significant paths in the research model are shown in Figure 4 and the results of overall hypotheses tests are summarized in Table IX.

Conclusion

Implications of the study

The results of this study suggest a number of interesting insights concerning GSCM. First, this paper adopted conceptual footing from RDT for GSCM practice implementation to investigate the effects of collaboration effort between SME suppliers and large buying firms. We took the supplier's perspective in explaining the weaknesses of SME suppliers in order to emphasize the importance of the support from large firms for improving suppliers' environmental management capabilities and business performance. Krause *et al.* (2000) argued, in general, the necessity and importance of buying firms' involvement to help enhance suppliers' performance because buying firms' such efforts would have a positive influence on the business performance of the supplier firms. More specifically, prior studies asserted that to prevent any environmental accidents made by SME suppliers and to improve their own GSCM practices, large buying firms need to be involved with their suppliers' GSCM activities (Lee, 2008; Lee and Klassen, 2008). Moreover, SME suppliers perceive that the implementation of GSCM practices helps improve the relational efficiency with their buyers and eventually achieve better business performance.

Second, this research extends the literature on the implementation of GSCM practices. The measurement model of GSCM practice implementation employed in this study was developed and tested mostly in China (Zhu and Sarkis, 2004; Zhu *et al.*, 2008). The contribution of this research is significant in that it is one of a few empirical studies that used the measurement items and scales for evaluating GSCM practice implementation among Korean electronics firms and attempted to refine the measurement items with modification. Zhu *et al.* (2008) developed the construct of GSCM practices implementation and tested a higher-order measurement model. Our results also show that all underlying constructs of GSCM practices implementation are governed by the second-order factor. This result supports the study of Zhu *et al.* (2008). One other meaningful outcome of our study is that newly added measurement items in our research, such as "cooperation with customers for developing environmental database of products," "design of products for disassembly," and "design of products considering life cycle assessment," were also well correlated for the constructs.

Third, the findings of this study are largely consistent with the observation of Zhu and Sarkis (2006). Zhu and Sarkis (2006) discussed that since the EU's new directives on electronic equipment and substances became in effect, the electronics industry has been more mature in adopting GSCM practices in China. Table III shows a good acceptance rate of ISO 14001 among Korean SMEs in the electronics industry. Most of the suppliers (96.4 percent) surveyed have implemented ISO 14001. This indeed is a huge improvement in Korean electronics industry in terms of environmental quality management, compared to only 82 out of all Korean SMEs that adopted ISO 14001 in 2002 (Jang, 2004). This evidence clearly presents that the ISO 4001 is required for suppliers in getting contracts with buying firms (Lee and Cheong, 2011). Furthermore, according to our survey, many medium-sized first-tier suppliers have been utilizing LCA and EMAS (EMAS) from the designing stage of their new products.

Fourth, companies that implement GSCM practices must ensure that both the organization and its employees accomplish the overall organizational objectives, such as cost saving, cycle time reduction, improved environmental quality, and overall greater customer values as well as individual goals of the employees. The mediation analysis

shows that business performance can be enhanced through the achievement of operational efficiency after a company adopts GSCM practices. In addition, our study argues that employees who are currently satisfied with GSCM practices could later become dissatisfied. As large buying firms become more proactive concerning environmental issues, they will begin to extend the list of the environmental requirements for the products that they purchase from their suppliers. Then, the employees of these suppliers will realize the pressure from external stakeholders (i.e. buyer firms and governments) as well as from management, and will probably become resistant to such changes.

Limitations and future research needs

This study has some limitations that would provide opportunities for further research. First, the survey instrument should be reinforced and refined. Studies on GSCM are still at the early stage in developing proper measurements on GSCM practices and organizational performance. Developing good assessment tools on GSCM is critical, especially for SME suppliers. SME supplier firms are in need of self-diagnostic tools to check their environmental management capabilities. Academia should provide such diagnostic tools or a checklist to help the firms identify their problem areas and create solutions. To this end, we will continue this research to refine the survey instrument and correct any measurement errors.

Second, we chose electronics firms in Korea for data collection and analysis as this industry is under stringent environmental regulations. Hence, the results may not have strong external validity. To increase generalizability of the research, repeating this study for comparative analysis in different industries as well as in different countries will be another research direction.

Third, we assessed organizational performance using rather general factors such as asset utilization, competitive position in the market, and profitability. In the future research, more specific measurement items should be used to evaluate an organization's business performance – financial indices, innovation, detailed environmental performance measures, and the like.

This study has made an initial effort to explain the direct and indirect effects of employee job satisfaction, operational and relational efficiencies on the link between GSCM practice implementation and business performance for small- and medium-sized electronics firms. As GSCM is playing an increasingly important role in sustaining competitive advantage (Rao and Holt, 2005; Testa and Iraldo, 2010), firms should seriously investigate how to leverage GSCM practices to facilitate both operational and relational efficiencies and eventually gain greater competitiveness in the dynamic global market place.

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Appendix. Survey questionnaires

Table AI. Measurement items for GSCM practice implementation

Factors	Measurement items
Internal environmental management (IEM)	IEM1: senior managers' commitment on GSCM IEM2: mid-level managers' support of GSCM IEM3: cross-functional cooperation for environmental improvements IEM4: environmental compliance and auditing programs IEM5: ISO 14001 certification Reference: Zhu *et al.* (2008)
Green purchasing (GP)	GP1: eco labeling of products GP2: cooperation with suppliers for environmental objectives GP3: environmental audit for suppliers' internal management GP4: suppliers' ISO 14000 certification References: Chen (2005), Zhu *et al.* (2008)
Cooperation with customers (CC)	CC1: cooperation with customers for eco-design CC2: cooperation with customers for cleaner production CC3: cooperation with customers for green packaging CC4: cooperation with customers for developing environmental database of products References: Hsu and Hu (2008), Zhu *et al.* (2008)
Eco-design (ECO)	ECO1: design of products for reduced consumption of material/energy ECO2: design of products for reuse, recycle, recovery of material, component parts ECO3: design of products to avoid or reduce use of hazardous products and/or their manufacturing process ECO4: design of products for disassembly ECO5: design of products considering LCA References: Matos and Hall (2007), Rusinko (2007), Zhu *et al.* (2008)

Notes: A five-point scale: 1 – not considering it, 2 – planning to consider it, 3 – considering it currently, 4 – initiating implementation, and 5 – currently implementing

Table AII.
Measurement items for the mediators and business performance

Factors	Measurement items
Employee job satisfaction (SAT)	SAT1: most employees like their jobs in the present operations
	SAT2: most employees think their supervisor treats them well
	SAT3: most employees in our firm like their jobs more than many employees of other firms
	SAT4: most employees in our firm do not intend to work for a different company
	SAT5: overall, our employees are quite satisfied with their jobs
	References: Homburg and Stock (2004), Zhou *et al.* (2008)
Operational efficiency (OE)	OE1: cycle time has been reduced
	OE2: overall, costs have been lowered
	OE3: overall, products' quality has been improved
	OE4: customer service has been improved
	OE5: project duration has been reduced
	OE6: our firm has delivered greater value to our customers
	References: Rusinko (2007), Paulraj *et al.* (2008), Zhu *et al.* (2008), Zacharia *et al.* (2009)
Relational efficiency (RE)	RE1: an increased respect for the skills and capabilities of customers
	RE2: an improved level of honesty
	RE3: more open sharing of information with our customers
	RE4: a more effective working relationship with our customers
	RE5: an enhanced commitment to work with our customers in the future
	RE6: an overall more productive working relationship with our customers
	Reference: Zacharia *et al.* (2009)
Business performance (BP)	BP1: better asset utilization
	BP2: stronger competitive position
	BP3: improved profitability
	BP4: overall improved organizational performance
	References: Zhu *et al.* (2008), Zacharia *et al.* (2009)

Notes: A five-point scale: 1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, and 5 – strongly agree