The complementarity of green supply chain management practices and the impact on environmental performance

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Abstract

Although the importance of integrating different Green Supply Chain Management (GSCM) activities has been highlighted in the literature, the potential interdependencies between these practices and their performance impacts have not been investigated. The purpose of this study is to examine the collective impact of internal and external GSCM practices on two aspects of environmental performance: environmental impact and environmental cost savings. GSCM is proposed as a collective competency, combining four distinct, but interrelated, sets of practices: environmental management systems, eco design, source reduction and external environmental practices. Using survey data from 138 Omani manufacturing firms and Structural Equation Modelling, we find strong empirical support for the complementarity of GSCM practices. We find a strong positive relationship between the level of collective GSCM competency and the environmental impact achieved. Our findings support the belief that complementarities between GSCM practices lead to better performance. Managers should therefore focus on implementing bundles of GSCM practices rather than searching for individual best practices. We find an indirect, mediated influence on environmental cost savings, which is consistent with previous results in other emerging market contexts.

Keywords: Green Supply Chain Management; Structural Equation Modelling; Complementarity Theory; Environmental Performance; Survey Research

1. Introduction

Growing environmental awareness imposes ever greater challenges to enterprises. Many companies place environmental objectives on their agenda and engage in Green Supply Chain Management (GSCM) activities, including eco-design, sustainable sourcing, recycling and remanufacturing. These initiatives are key contributors to competitiveness (Dahlmann *et al*., 2008; Zhang *et al*., 2008), but do not always create economic benefit (Bowen *et al.,* 2001; Zeng *et al*., 2010a; Fahimnia *et al.,* 2015; Aigbedo, 2019). Some studies find a positive correlation between environmental commitment and economic performance (e.g., Molina-Azorín *et al*., 2009; Green *et al.,* 2012a & 2012b; Gotschol *et. al.,* 2014), but other studies report no significant relationship (Matos and Jeremy, 2007; Sarkis and Dijkshoorn, 2007). These mixed findings highlight the complexity in linking the two constructs, and may be due to differences in the modeled relationships, the sets of environmental activities and aspects of business performance and/or the metrics for these entities. Zhu *et al*. (2012 & 2013), for example, investigate internal and external GSCM initiatives and the relationships with performance separately in recognition that some firms pay more attention to greening the internal operations and others focus on greening the supply chain activities. More and more firms, however, consider an integrated set of GSCM practices with both internal and external activities. The potential interdependency of different environmental practices has been largely ignored in the literature (Claver *et al*., 2007).

Supply chain management researchers have documented how inter and intra-organizational collaboration can enhance enterprise performance (e.g., Green *et al.,* 2007; Flynn *et al*., 2010; Lewis *et al.,* 2010; Wong *et al.*, 2011). More recent studies also argue for the importance of coordinating environmental efforts. At the heart of these studies is the debate on the dependency (complementarity) or independency (substitutability) of GSCM practices and the impact on performance. Both contingent (Wong *et al.*, 2012), sequential/mediated (Green *et al.*, 2012a; Zhu *et. al*., 2012), and independent relationships (Zhu *et al.,* 2007; De Giovanni, 2012) can be found in the literature. To the best of our knowledge, no attempt has been made to study the interdependency of internal and external GSCM practices from a more holistic, complementarity perspective. This view may well enable a more comprehensive, and potentially altered, understanding of how GSCM initiatives and performance are related. The main objective in this paper is to examine the collective impact of internal and external environmental initiatives on two aspects of business performance: environmental impact and environmental cost savings.

Environmental impact can be defined as the possible adverse effect that a business may have on the environment through the use and release of substances from/into the environment. Environmental costs include internal costs that directly impact on the income statement of a company (e.g. waste treatment and discharge cost, energy consumption, product take back costs) and external costs that are imposed on society at large, but not borne by the company that generates the cost in the first instance (e.g. carbon emissions, forest degradation, social welfare cost) (Jasch, 2003; Bovea and Vidal, 2004). We focus in this paper on the internal cost savings.

The complementarity theory (Milgrom and Roberts, 1995) forms the theoretical foundation of our study. We argue that the firm's ability to simultaneously develop and adopt various environmental practices is a source of sustainable competitive advantage due to the super-additive impact. We call this the *"collective GSCM competency"*. The collective GSCM competency integrates four distinct, but interrelated, sets of proactive environmental practices: i) Environmental Management Systems, ii) Eco-Design, iii) Source Reduction and iv) External Environmental Management.

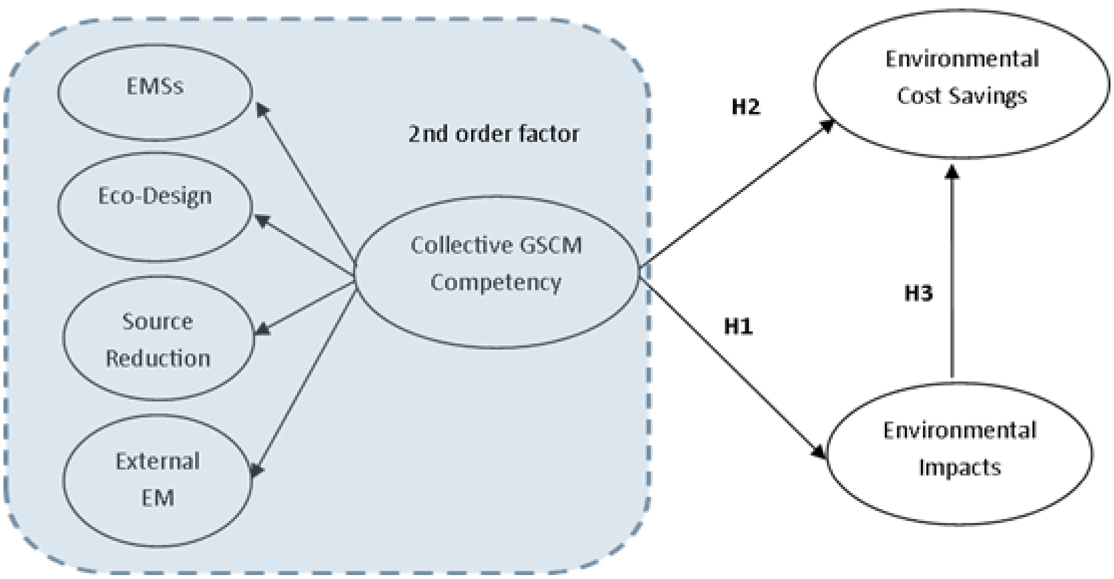

Figure 1: Conceptual collective GSCM competency model

The motivation behind our approach is that an isolated adoption of routine-based environmental practices is typically not enough to achieve positive environmental and business impact. When various environmental practices operate as a single integrated power, they may show greater impact. Figure 1 illustrates the conceptual collective GSCM competency model and shows how complementarities between GSCM practices may contribute to better performance. We study both the direct effect of the collective GSCM competency on environmental impact (arc H1) and on environmental cost saving (arc H2), and the indirect, mediated effect of the collective GSCM competency on environmental cost saving via environmental impact (arc H3).

To complete our investigation, we collect survey data from Omani manufacturing firms and use Structural Equation Modelling (SEM) to analyze the survey results. Oman has not received much attention in the Operations and Environmental Management literature. Previous GSCM studies have focused on the U.S. (e.g., Green *et al.*, 2012a & 2012b), other Western contexts (e.g., Wales, U.K. in Sarkis and Dijkshoorn, 2007; Europe, in Aigbedo, 2019) and on China (e.g., Zhu and Sarkis, 2004; Zhu *et al.*, 2008; Li, 2014). We had the opportunity to access the Omani manufacturing sector, fully supported by the Omani Ministry of Commerce and Industry. GSCM is particularly important to enhance the attractiveness of Omani manufacturing companies, and enable them to enter into the global networks of large multi-national companies. A comparison of our results in Oman with findings from previous studies in China and the U.S. can support a strong, generalized conclusion about the relationship between environmental practices and business performance.

Our paper is organized as follows. In Section 2, we present the literature in support of the research hypotheses. We discuss GSCM practices and introduce the complementarity theory, which we use to conceptualize the constructs and model (Figure 1). Like in Mishra and Shah (2009), we propose a proposition for the existence of a higher order collective GSCM competency construct, followed by hypotheses concerning the environmental and cost saving impact of the collective GSCM competency. Section 3 discusses the survey and data analysis approach. The results of hypotheses tests are presented in Section 4 and discussed in Section 5. Conclusions follow in Section 6 along with suggestions for future research.

2. Literature and hypotheses development

2. 1 Green supply chain management initiatives

We adopt a comprehensive definition of GSCM and consider both internal and external initiatives in our conceptual model (Figure 1). GSCM is defined as: management systems, production equipment, methods and procedures, product designs and product delivery mechanisms that conserve energy and natural resources; minimize environmental impact of human activities, and protect the natural environment (Klassen and Whybark, 1999; Zhu and Sarkis, 2004). Several GSCM practices have been considered in the literature (see Table 1).

Table 1: Environmental management practices in the literature

Study	GSCM activities
Bowen *et al*. (2001)	Strategic purchasing and supply, product-based green supply, corporate environmental pro-activity, greening the supply process
Buysse and Verbeke (2003)	The end-of-pipe, pollution prevention, product stewardship, sustainable development
Melnyk *et. al.* (2003)	Life cycle assessment, environmental management systems (EMSs)
Rao and Holt (2005)	Greening the inbound function, greening production, greening the outbound function
Zhu and Sarkis (2004), Zhu *et al.,* (2005 & 2007)	Eco-Design, investment recovery, EMSs, collaboration with customers and suppliers
Sarkis *et al.,* (2010)	Eco-Design, source reduction, EMSs
Delmas and Toffel (2008)	EMSs, government-initiated voluntary environmental programs
Sharma and Henriques (2005)	Pollution control, eco-efficiency, recirculation, eco-design, EMSs
Gonzalez-Benito and Gonzalez-Benito (2005)	Planning and organizational, operational (product related), operational (process related) and communicational activities
Vachon and Klassen (2006); Vachon (2007)	Environmental collaboration, environmental monitoring
Shang *et al.,* (2010)	Green manufacturing and packaging, environmental participation, green marketing, green suppliers, green stock, and green eco-design
Green et al., 2012a	Internal environmental management, green information systems, green purchasing, cooperation with customers, eco-design, and investment recovery
Green et al., 2012b	Internal environmental management; green information systems; environmental cooperation with suppliers; environmental cooperation with customers; environmental monitoring of suppliers; environmental monitoring of customer
Wu *et al.,* (2012)	Green purchasing, cooperation with customers, eco-design and investment recovery
Zhu *et al.,* (2012)	External and internal activities

We look at four sets of practices in our research: Environmental management systems, Eco-design, Source reduction and External environmental management initiatives. These four sets of practices provide a broad combination of proactive activities that are widely used by companies, and that have also been considered in other studies as among the most prominent environmental solutions for manufacturing firms (see Table 1). The four sets of practices are represented as nodes (first order constructs) in Figure 1. We elaborate on these sets of practices in the following subsections.

2.1.1 Environmental management systems (EMSs)

EMSs can be defined as *"the formal systems and databases, which integrate procedures and processes for the training of personnel, monitoring, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders of the firm"* (Melnyk *et al.*, 2003). Both managers and researchers recognize the importance of certified EMSs (e.g. ISO 14001) to eliminate or avoid economic risks. EMSs assist in complying with voluntary and mandatory environmental standards (Darnall, 2006; Darnall and Edwards, 2006) and in achieving waste reduction goals by better environmental planning from the acquisition of raw materials through to the distribution of finished products. The implementation of these internal systems can foster the development of inter and intra-organizational collaboration and facilitate other environmental initiatives within and across the firm. The emphasis in adopting EMSs is on the process rather than on reaching a certain level of environmental performance; EMSs help in the development of green initiatives and in achieving environmental objectives (Sroufe, 2003).

2.1.2 Eco-design (ED)

ED, also called 'design for the environment', refers to the extent to which firms generate products and/or production processes that have minimal impact on the natural environment (Zhu *et al.*, 2008). It is a long term pollution prevention strategy that considers the design of products for easy disassembly, remanufacturing or recycling (Tukker *et al*., 2001), and involves various green activities over the product life cycle, including environment-friendly disposal. An ED strategy can offer firms several advantages over their competitors through the production of more durable products and the design of products or production processes with less energy consumption. The successful implementation of these practices requires investment in developing infrastructures such as technology and human resources, as well as close collaboration with customers and suppliers (Vachon and Klassen, 2006; Vachon, 2007).

2.1.3 Source reduction (SR)

SR practices are operational pollution prevention strategies aiming at eliminating or reducing the volume of waste generated from the firm's operations (Sarkis *et al*., 2010). SR involves waste management, input substitution, advanced inventory management, reduction in materials used during production or distribution and internal recycling (Gupta, 1995). SR is associated with total quality environmental management programs that focus on preventing or reducing the source of production waste (Melnyk *et al.*, 2003). These can be achieved through the improvement of product or production process designs and through green purchasing strategies (Wu *et al.*, 2012).

Both ED and SR are pollution prevention strategies that consider the design of products or production processes (Tukker *et al*., 2001). They strive to achieve a more efficient utilization of resources by evaluating how business is conducted, what materials/components are purchased and how these are used. Through pollution prevention firms can outperform competitors by exceeding, and not just matching, environmental regulations (Zhu and Sarkis, 2004; Zhang *et al.*, 2008). This suggests that ED and SR initiatives are not just good for the environment but also economically beneficial.

2.1.4 External environmental management practices (EEM)

EEM practices aim to identify and reduce environmental impacts throughout the supply chain by extending environmental management outside the firm's internal operations (Vachon, 2007). Firms increasingly add environmental considerations into supplier selection criteria and request suppliers to develop environmental management capabilities and/or provide accreditations to specific standards (Darnall, 2006). Companies do so to ensure that suppliers and the materials purchased meet sufficient environmental standards, which, in turn, can reduce the economic risks associated with production (Handfield *et al.*, 2002). More and more firms recognize the importance of close collaboration with customers and suppliers to successfully develop sustainable programs, to reduce the environmental and economic risks throughout the product life-cycle and to develop eco-designed products and processes (Min and Galle, 2001; Vachon and Klassen, 2006).

2.2 Complementarity theory and environmental management

The notion of complementarities between organizational activities flourishes in the literature and can be traced back to the super-modular optimization theory, introduced by Milgrom and Roberts (1990). Complementarity occurs when the value of one resource increases in the presence of other related resources. It occurs when the total value resulting from the combination of two or more interrelated factors in a production system exceeds the value that would be generated by using these factors separately. Ennen and Richter (2010) argue that complementarity between groups of activities can be a powerful performance driver.

The idea of complementarities between activities has been empirically validated in the context of human resource management (Cassiman and Veugelers, 2006), information technology (Melville *et al*., 2004) new product development (Mishra and Shah, 2009) and supply chain management (Flynn et al., 2010). It has not been investigated in a GSCM context (Touboulic and Walker, 2015). Our research aims to address this gap in the literature. We argue that the simultaneous adoption of various GSCM practices is more valuable and can enable better environmental and business performance than when these practices are considered separately.

Klassen and Whybark (1999; 604) believe that *"strategic choices must include structural, infrastructural and integration areas and that any assessment of environmental management should consider similar theoretical areas".* Indeed, from a complementarity perspective, managers should not focus on individual best practices; they must consider whole systems and the interactions between activities to achieve the best outcomes (Ennen and Richter, 2010). By combining external and internal resources and capabilities, a firm can establish a sustainable competitive advantage (Lewis *et al.*, 2010). This explains why resource complementarity is particularly important in order to: enhance an organization's environmental management capability (Hart, 1995), to respond more effectively to various environmental challenges, and to improve its performance. The collective GSCM competency requires complementary practices, and encourages continuous adjustment of the allocated resources for the development of these practices. The collective GSCM competency can differentiate the firm from its competitors and be a source of long lasting competitive advantage because firms may combine GSCM activities in different ways (Claver *et al.*, 2007).

Following suggestions in previous studies (e.g., Cassiman and Veugelers, 2006; Mishra and Shah, 2009; Ennen, and Richter, 2010), we conceptualize the development and simultaneous deployment of various complementary environmental initiatives as the second order 'Collective GSCM Competency' construct in Figure 1. It includes the four sets of environmental activities described earlier: EMSs, ED, SR and EEM. These practices are complementary and cohesive, with a synergetic impact on performance. For example, the involvement of external supply chain members is important to successfully design environmentally friendly products and production processes, including reverse logistics and re-manufacturing activities (Vachon 2007; Sarkis *et al*., 2010). Seitz and Peatty (2004) also claim that developing environmental practices can be hard without effective customer and supplier collaboration or without commitment from managers and employees. Wong *et al.* (2012) argue that the success of internal green operations is dependent on the environmental capabilities of suppliers, and Carter *et al.* (2000) and Green *et al.,* (2012a) find that internal management systems and cross-functional collaboration and information sharing are central to designing products for reuse, recycling or disassembly. Zsidisin and Hendrick (1998) find that inter-departmental collaboration and environmental auditing systems are important to effectively employ external GSCM initiatives such as green purchasing.

We conceptualize the complementarity of environmental practices through the following proposition:

P: The collective GSCM competency is a multi-dimensional, higher order construct comprised of several complementary internal and external proactive environmental practices (EMSs, SR, ED and EEM).

2.3 The environmental performance impact of GSCM initiatives

Growing environmental pressures have resulted in an increasing need to effectively integrate various resources and GSCM capabilities (Zhu and Sarkis, 2004; Wagner, 2011). There is evidence from earlier studies of the potential influence of the collective GSCM competency on environmental performance.

2.3.1 Influence on environmental impact

When improvement in environmental impact is defined as reducing pollution levels (Theyel, 2000), initiatives like EMSs, ED, SR and EEM can help. Previous studies suggest that internal environmental practices such as employee involvement, top management support and implementing formal EMSs may have long term implications on environmental performance because they organize and improve the daily operations of the firm (Bowen *et al.*, 2001; Melnyk *et al.*, 2003; Zeng *et al.*, 2010a). The development of more advanced environmental programs (like SR and ED) has been recognized as a good way to achieve drastic reductions in waste generation, and to reduce the overall environmental impact of the firm's products and operations (Zhu and Sarkis, 2004). External environmental initiatives have also grown in importance. Vachon (2007) and Green *et al.,* (2012b) found that the development of environmentally oriented relationships with suppliers and/or customers can lead to innovative environmental solutions. Similarly, green purchasing and supply management policies are found to be useful to improve environmental performance (Green *et al*., 1998).

While employing a single environmental practice can be costly or create only marginal performance improvements, using different environmental practices in combination often indicates a higher commitment to the cause and may create higher performance impact. We hypothesize that, due to the complementarity of different proactive GSCM practices, their collective environmental impact is greater than the sum of the individual environmental benefits of each one of these practices separately. Hence, the following hypothesis is set (see arc H1 in Figure 1):

H1: The collective GSCM competency is positively related to the firm’s environmental impact.

2.3.2 Influence on environmental cost savings

Using GSCM practices is not only driven by stakeholder pressures but also by the desire of companies to improve their business (Bowen *et al*., 2001; Almeida *et al.* 2019). Growing evidence suggests that the implementation of proactive GSCM practices can lead to long term economic advantages by reducing the penalty costs associated with environmental risks of company operations. Furthermore, environmental initiatives directly related to market requirements (e.g., design of environmentally friendly products) can provide market entry opportunities and increase sales and profitability (Zhu *et al*., 2008). Green management activities can enhance business image and reputation, and reducing the environmental impact of products may boost product demand (Peng and Lin, 2008; Molina-Azorín *et al.,* 2009). Some studies maintain that SR can improve operational efficiency through waste reduction and cost savings, ultimately resulting in improved economic performance (Sarkis *et al*., 2010). Formal EMSs are also important to provide the firm with access to new sources of capital and improve its reputation (Melnyk *et al*., 2003; Jacobs *et al*., 2010). Moreover, a more innovative production process that helps to improve the economic position of the firm can be achieved by establishing environmentally oriented cooperative relationships with customers and suppliers (Vachon, 2007; Vachon and Klassen, 2008). The literature clearly argues for the importance of an integrative and comprehensive set of proactive GSCM efforts (Green *et al.*, 2012a; Wong *et al.,* 2012; Zhu *et al.*, 2012) and highlights numerous business advantages by adopting these practices. Whilst several sets of green practices (despite their interactions– see Section 2.2) have been individually correlated with business performance and cost savings, the overall impact of a holistic GSCM competency on environmental cost saving has not been explored. We address this issue in our study, and hypothesize that, due to the complementarity of these practices, the impact of the collective GSCM competency on business performance (here measured as environmental cost savings) is greater than the total impact by considering each of these practices separately. Accordingly, we propose the following hypothesis (see arc H2 in Figure 1):

> *H2: The collective GSCM competency is positively related to the firm's environmental cost savings.*

2.3.3 Relationship between environmental impact and environmental cost savings

Companies are more likely to implement various environmental practices when these efforts lead to economic value (Almeida *et al.* 2019). The firm's reputation, public relations and share price are likely to be enhanced when a firm announces good levels of environmental performance (Jacobs et al., 2010). Environmentally sensitive customers are also more interested in buying products from companies that spend more effort on reducing environmental impact (Hart, 1995; Wu *et al*., 2012). Likewise, SR and ED activities can improve productivity levels and efficiency of a firm (Zhu and Sarkis, 2004; Zhu *et al.*, 2012). Several studies suggest an indirect, mediated, relationship between GSCM initiatives and business performance (Green *et al*., 2012a; Dixton-Fowler *et al.*, 2013; Zhu *et al.*, 2013). To the best of our knowledge, no study has examined the indirect, mediated, impact of the collective GSCM competency on environmental cost savings through the environmental impact of the firm. Accordingly, we hypothesize (see arc H3 in Figure 1):

> *H3: The firm's environmental impact is positively related to the environmental cost savings that the firm achieves. Environmental impact mediates the influence of the collective GSCM competency on environmental cost savings.*

3. Survey approach

We explain in this section how the different model constructs are measured, how we administered the questionnaire (see Appendix), and how we controlled for bias.

3.1 Construct measurements

The GSCM constructs in Figure 1 are measured through multiple indicators (see Table 2) from the literature so as to ensure a high degree of validity. The questionnaire included 17 items related to GSCM practices (SR 3 items; ED 3 items; EMSs 5 items and EEM 6 items) and 9 items related to performance (EnvI 5 items and Sav 4 items). The contextual reliability of the constructs was affirmed through preliminary meetings with managers from the industry and the government in Oman. These meetings revealed that Omani firms employ environmental practices, similar to those in other developing countries (such as China), but very limited attempts were made by Omani firms to start environmental initiatives related to the use of green energy. Omani managers also stated that cumulative data related to economic and environmental performance of Omani firms are not publicly available. All the items used in our study were taken from the literature (see references in Table 2), but for some the wording was slightly modified to ensure that the terminology and language was understandable to the respondents. These minor modifications were made based on interviews with managers and pilot study results. All GSCM items were measured on a 1-5 point Likert's scale. Managers were asked to evaluate the extent to which their company had developed the listed environmental practices, using the following scores: 5 = carrying it out fully, 4 = carrying it out to some degree, 3 = considering it currently, 2 = planning to consider it, and 1 = not considering it. Performance items were also measured on a five point scale. Managers evaluated the extent to which several aspects of performance had improved as a result of implementing GSCM practices, using the following scores: 1 = not at all, 2 = a little bit, 3 = to some degree, 4 = relatively strong, 5 = very significant. Measuring environmental practices and performance through the self-perception of managers is not uncommon in the literature (Aragon-Correa et al., 2008).

The items for the GSCM practices are well established in the literature (see references in Table 2). We discuss our selection of outcome related metrics in more detail. With regards to environmental performance, various measurements were used in previous studies, and yet no common measurement exists (Montabon *et al.,* 2007). Some studies have concentrated on the public reaction to environmental activities (i.e. stakeholder satisfaction, e.g., Rueda-Manzanares *et al.*, 2008) and the features of effective practices (e.g., Gonzalez-Benito and Gonzalez-Benito, 2005), while others have used more explicit measures related the environmental outcomes of green practices. We focus on the latter and measure the *Environmental Impacts* construct in Figure 1 through five items from Zhu and Sarkis (2004 & 2007) and Zhu *et al.* (2007), which evaluate the reduction of various environmental emissions and harmful effects (Table 2, EnvI).

The economic impact of GSCM activities is measured through more operational rather than aggregate, financial performance measures, such as market share and profitability. Most environmental practices have a strong operational focus, suggesting that appropriate metrics to measure their effects should also be operationally focused (Melnyk *et al*., 2003; Zhu and Sarkis, 2004; Vachon and Klassen, 2008). This approach was also recommended and employed in previous studies conducted in less developed countries (e.g. Zhu and Sarkis, 2004; Eng Ann *et al*., 2006). Because the GSCM practices focus on the environment, we also feel that the operational performance improvement that can potentially be derived relates to their 'nature-saving' mechanism and impact. Specifically, we measured the economic impact of GSCM initiatives (*Environmental Cost Savings* construct in Figure 1) by items from Zhu and Sarkis (2004 & 2007) and Zhu *et al.* (2007) but we include only those items directly related to ecological and energy costs (see Table 2).

3.2 Control variables

We control for the effects of firm size (number of full-time employees[1]), age of the firm (total years in business), and the degree of pollution intensity of the industry to which a firm belongs. Larger firms may have easier access to resources (Alvarez Gil *et al*., 2001), making it easier to invest in environmental protection (Sharma and Vredenburg, 1998). Firm age can also influence the company's environmental

[1] Although 'firm size' has many dimensions and other, e.g., financially based metrics like sales and capital can be used, these data may be much more difficult to obtain, especially in developing countries where company financial data are not readily available. The number of full-time employees as a proxy indicator for firm size is a common approach in GSCM and SCM studies (e.g., Zhu and Sarkis, 2004; Vachon and Klassen, 2006; Vachon, 2007; Mishra and Shah, 2009; Sarkis et al., 2010; Wagner, 2011).

performance (Theyel, 2000). Modern green facilities and technologies used by younger firms enable more efficient production, lower environmental emissions and more savings of resources.

Table 2: Items used to measure the constructs and their sources

Construct	Items	Sources
Source-reduction (SR)	Use of recycled materials in production (SR1) Reducing the variety of materials used in the production (SR2) Avoidance of harmful materials or components (SR3)	Sarkis et al. (2010) (wording slightly modified)
Eco-design (ED)	Redesigning the product or the production process (ED1) Using packaging and pallets which can be reused (ED2) Increase the life cycle of the product (ED3)	Zhu and Sarkis, 2004 & 2007; Wu et al., 2012 (wording slightly modified)
Environmental Management Systems (EMSs)	Using advance inventory management techniques (EMSs1) Cross functional cooperation (EMSs2) Providing ongoing support from top management (EMSs3) Regular maintenance of the production equipment (EMSs4) Providing training to employees/managers on various environmental management areas (EMSs5)	Melnyk et al., 2003; Zhu & Sarkis, 2004 & 2007 ; Sarkis et al., 2010 (wording slightly modified)
External Environmental Management (EEM)	Including environmental considerations in selection criteria for suppliers (EEM1) Achieving environmental goals collectively with our main suppliers (EEM2) Providing suppliers with written environmental requirements for purchased items (EEM3) Providing customers with written environmental information related to our products (EEM4) Working with customers to develop a mutual understanding of responsibilities regarding environmental performance (EEM5) Conducting joint planning sessions, workshops and knowledge sharing activities with suppliers to anticipate and resolve environmental-related problems (EEM6)	Vachon and Klassen, 2006 ; Vachon, 2007 ; Zhu *et al.*, 2012 (wording slightly modified)
Environmental Impact (EnvI)	Reducing consumption of harmful materials (EnvI1) Reduction of air emissions (EnvI2) Reduction of water emissions (EnvI3) Reduction of solid waste disposal (EnvI4) Reduction of environmental accidents (EnvI5)	Zhu and Sarkis, 2004 & 2007; Zhu *et al.*, 2007
Environmental Cost Savings (Sav)	Decrease of fee for waste treatment (Sav1) Decrease of fee for waste discharge (Sav2) Decrease of cost for energy consumption (Sav3) Decrease of material purchasing costs (Sav4)	Zhu and Sarkis, 2004 & 2007; Zhu *et al.*, 2007

The level of pollution intensity of the industry sector can impact on the environmental outcomes of a firm (Zeng et al., 2010b). Firms operating in highly polluted industries (e.g., cement, chemicals and oil refining) are more environmentally sensitive than others and tend to produce more negative externalities to the environment compared to those operating in less polluted industries (Bowen *et al.*, 2001). Highly polluting firms may also be more interested to increase investments in green initiatives in order to legitimize their operations (Sharma *et al.*, 1999; Berrone and Gomez-Mejia, 2009).

The control variables are added in the Structural Equation Models as dummy variables. Based on the median values of the number of employees and the total years in business, firms with less or equal than 145 full time employees are coded as 0, and others are coded as 1. Similarly, firms with less or equal than 16 years in business are coded as 0, and those with more than 16 years in business are coded as 1. Pollution intensity was proxied by the industry category as suggested in previous studies (e.g. Bowen *et al.*, 2001; Zeng *et al.,* 2010b). We applied the classification of the Omani Ministry of Environment and Climate Affairs and labelled firms as 'highly polluting' (coded = 1, n=85, including industries of Refined oil & liquid natural gas, Chemical products, Plastic products, Non-metallic mineral products, Paper & paper products, Electronic appliances & electronic machines and Manufacturing of machines & equipment) or 'light polluting' (coded = 2, n=53, other industry sectors).

3.3 Translation and pilot test

The questionnaire was translated into Arabic by two professional bilingual translators using the back-translation approach (Brislin, 1970). Both English and Arabic questionnaires were used in Oman, but respondents were asked to answer only the version in their preferred language. Several procedures were used to ensure clarity and content validity of our instrument (Malhotra and Grover, 1998). First, an extensive literature review was conducted to identify the existing scales to measure the constructs that are characteristic for manufacturing in developing countries. Second, a draft questionnaire was reviewed by academics and experts in environmental and operations management. Semi-structured interviews were also conducted with two industry experts to ensure that the items used in the questionnaire reflect industry practice. Finally, the revised questionnaire was piloted to 15 randomly selected potential respondents. The feedback from these respondents was used to further improve the questionnaire.

3.4 Sample and data collection

The sampling frame contains the whole population of medium and large manufacturing firms in Oman (with more than 20 employees) as listed in the Omani Ministry of Commerce and Industry database. We contacted all 574 firms. It was argued that firms with fewer employees were less motivated to use green practices because they may lack sufficient resources (Raymond *et al.*, 2008). The Ministry database provided contact details of the companies. The contact details of potential respondents, who would be knowledgeable of the topic surveyed, were gathered via phone calls to the companies. We targeted a single respondent from top or middle level management in each firm, which is also consistent with other GSCM studies (e.g. Zhu et al., 2005 & 2013).

Our unit of analysis is the individual firm. Although the EEM construct relates to practices extending beyond the firm to relationships with suppliers, we concentrate on the focal firm's viewpoint only. Furthermore, the items used to measure EEM are also taken from studies with a focal company data collection approach (Vachon and Klassen, 2006; Zhu *et al.*, 2012).

The data collection commenced in December 2012 and concluded in March 2013. Initial calls were made to the respondents before the questionnaire was circulated (Frohlich, 2002). The questionnaire included a cover letter, guidelines on who should respond and a prepaid postal return envelope. Out of 574 questionnaires, a total of 94 responses were received in a first phase. All non-respondents were contacted by phone and were sent another copy of the questionnaire. This second phase yielded an additional 59 responses, resulting in a total response rate of 26.66% (153/574). Fifteen responses were discarded due to incomplete information, bringing the effective response rate to 24% (138/574) of the population under study.

The respondents are top-level executives in the position of general manager, operations manager or production manager - the vast majority of them with a work experience of more than 8 years in their firm. The distribution of the respondents' industries is as follows: chemical products (16.7%), fabricated metals (15.9%), plastic products (13.8%), electronic equipment (10.1%), non-metallic mineral products (9.4%), basic metals (9.4%) and the remaining (31.8%) are other industries such as refined oil & liquid natural gas, publishing activities and wood & paper products.

3.5 Controlling for bias

We tested for the possibility of non-response bias by performing an independent t-test and comparing the mean response value on two demographic variables: firm size and firm age. We randomly selected 10 measurement variables of dependent and independent factors and evaluated the set of early respondents (received within the first 30 days after distributing the survey) and the set of late respondents (Armstrong and Overton, 1977). The t-test revealed no statistically significant differences ($p< .05$) between the two groups, suggesting that non-response bias is not a critical issue. Further phone calls were made to twelve randomly selected firms from the non-respondents to clarify the reasons for no response. The most evident were time constraints and the firm's policy to dismiss survey invitations.

We confirmed the absence of common method bias in different a-priori and a-posteriori procedures as recommended by Podsakoff *et al*. (2003), Hair *et al*. (2010) and Chang *et al.* (2010). First, we separated the measurements related to the dependent and independent variables into different sections in the questionnaire and we used different response forms for these variables to eliminate the impacts of consistency artefacts. In addition, information related to GSCM practices and performance was obtained from managers who have the knowledge to comment on these issues. This was done by initially contacting the target respondents and asking for their participation. Then we posted the questionnaire with a reminder that it should be completed by the manager in charge of the environmental management in the company. The respondents have an average of fifteen years of work experience in their company; and they hold middle and higher-level management positions. They are the key informants on the GSCM activities that are used or planned in their companies. Further, three dummy questions related to GSCM practices and performance were added in the final version of the questionnaire. We tested if respondents provided similar answers to these questions. The cases with different responses for two or more dummy items were eliminated from further analysis. Then, we conducted Harman's single-factor test in which the un-rotated factor analysis with eigenvalue greater than 1 was used (Podsakoff *et al.*, 2003). The results of this test showed the presence of six different factors, and the first factor explained only a fraction of the variance (14.8%) in the data. To further strengthen this result, we used the Widaman (1985) procedure. We tested a measurement model having the studied constructs only, and another model with an additional common latent factor (Widaman, 1985). This common latent factor was created by correlating all indicators of the constructs into a single factor. The results of this test indicated that the added factor accounted for 5.7% of the total variance only, which is below the 10% threshold (Widaman, 1985). Also, the indicator loadings for the constructs were still significant after adding the latent factor and not much different between the models, suggesting that they were strong enough even after adding the latent factor. Additionally, some aspects of environmental performance were validated through secondary reports. These results suggested that common method bias was unlikely to influence the validity of our results (Podsakoff *et al.*, 2003).

4. Results

The proposed structure of the collective GSCM competency and the firm's performance is assessed through Confirmatory Factor Analysis (CFA) using Structural Equation Modelling (SEM). We follow a multistage approach (Anderson and Gerbing, 1988; Byrne, 2010). First, we evaluate the reliability and validity of the first order constructs that represent the different GSCM practices; then we test the reliability and validity of the second order collective GSCM competency construct. After establishing reliable and valid measures and constructs, we test the overall model fit and assess the size, direction and significance of the structural path coefficients. We test this in three steps: (a) using the first order constructs as independent variables, (b) using the second order construct as an independent variable, and (c) by adding the mediating link 'environmental impact→environmental cost savings' to the model (see Figure 1).

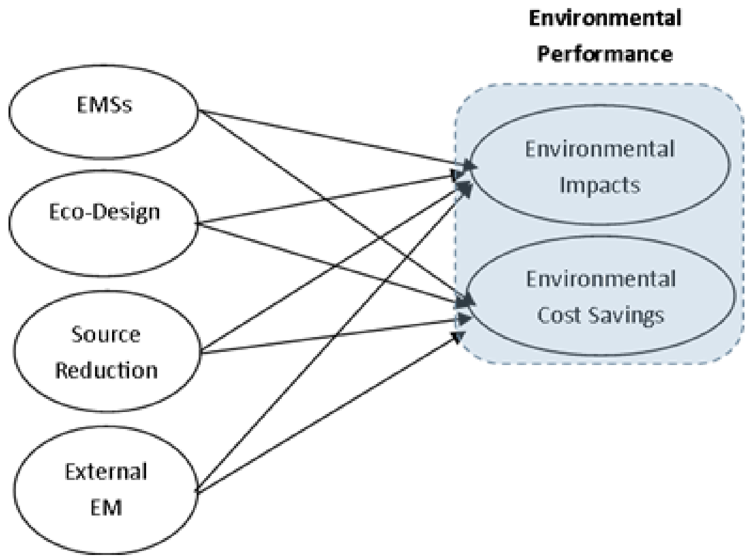

Figure 2: Individual effect model

Figure 2 shows the *individual effect* model, which includes the direct relationships between the four separate GSCM practices and the two dimensions of performance. The overall model fit is assessed through several indices including, chi-square and its associated degree of freedom, normed chi-square, goodness of-fit index (GFI), incremental fit index (IFI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and parsimony normed fit index (PNFI).

4.1 Measurement model analysis: Construct validity and reliability

The CFA results in Table 3 confirm that all indicators used to develop the first and second order constructs load above the typical threshold value of 0.7 (Hair *et al.*, 2010) onto their underlying constructs, except for two items (ED3 and EMSs1). These two items are removed. The standardized parameter loadings range from 0.681 to 0.881 (p<.01), and the Average Variance Extracted (AVE) for the constructs ranges from 0.54 to 0.67, indicating evidence of good convergent validity (Anderson and Gerbing, 1988). Uni-dimensionality and internal consistencies of constructs are established using Cronbach's α and composite reliability. All the values are greater than the generally accepted threshold of 0.7 (Nunnally, 1978). Fornell and Larcker (1981) suggest that construct discriminant validity is fulfilled when the square root AVE of the constructs is greater than correlation of the constructs. The results in Table 4 show that all constructs pass the Fornell-Larcker test so that discriminant validity of both the first and the second order measurement models is satisfied.

Table 3: Measurement properties of 1st and 2nd order constructs

Construct	items	Factorial weight	T-value	R^2	Cronbach's α	Composite reliability	AVE
Source-reduction (SR)	Use of recycled materials in production (SR1)	0.745 –	—	0.555	0.83	0.80	0.58
	Reducing the variety of materials used in the production (SR2)	0.722***	5.358	0.521			
	Avoidance of harmful materials or components (SR3)	0.806***	6.548	0.650			
Eco-design (ED)	Redesigning the product or the production process (ED1)	0.817–	—	0.668	0.73	0.80	0.57
	Using packaging and pallets which can be reused (ED2)	0.735***	6.818	0.575			
	Increase the life cycle of the product (ED3)	0.698**	6.265	0.538			
Environmental Management Systems (EMSs)	Using advance inventory management techniques (EMSs1)	0.681–	—	0.465	0.82	0.85	0.54
	Cross functional cooperation (EMSs2)	0.831***	8.63	0.691			
	Providing ongoing support from top management (EMSs3)	0.732***	7.348	0.539			
	Regular maintenance of the production equipment (EMSs4)	0.701**	6.714	0.491			
	Providing training to employees/managers on various environmental management areas (EMSs5)	0.713***	7.198	0.508			
External Environmental Management (EEM)	Including environmental considerations in selection criteria for suppliers (EEM1)	0.714–	—	0.615	0.93	0.92	0.67
	Achieving environmental goals collectively with our main suppliers (EEM2)	0.799***	10.06	0.619			
	Providing suppliers with written environmental requirements for purchased items (EEM3)	0.843***	11.615	0.771			
	Providing customers with written environmental information related to our products (EEM4)	0.874***	12.048	0.816			
	Working with customers to develop a mutual understanding of responsibilities regarding environmental performance (EEM5)	0.810***	10.591	0.670			
	Conducting joint planning sessions, workshops and knowledge sharing activities with suppliers to anticipate and resolve environmental-related problems (EEM6)	0.835***	11.334	0.695			
Environmental Impact (EnvI)	Reducing consumption of harmful materials (EnvI1)	0.881–	—	0.674	0.9	0.91	0.66
	Reduction of air emissions (EnvI2)	0.842***	11.44	0.709			

	Reduction of water emissions (EnvI3)	0.829***	11.193	0.686			
	Reduction of solid waste disposal (EnvI4)	0.789***	10.277	0.617			
	Reduction of environmental accidents (EnvI5)	0.781***	10.188	0.608			
Environmental Cost Savings (Sav)	Decrease of fee for waste treatment (Sav1)	0.874—	—	0.76	0.84	0.85	0.62
	Decrease of fee for waste discharge (Sav2)	0.818***	14.047	0.892			
	Decrease of cost for energy consumption (Sav3)	0.731***	7.141	0.790			
	Decrease of material purchasing costs (Sav4)	0.712***	6.524	0.506			
Collective GSCM	-Eco-design	0.782—	—	0.590	0.88	0.90	0.67
	-Source reduction	0.864***	5.288	0.747			
	-EMSs	0.871***	6.297	0.759			
	-External EM	0.773***	6.498	0.60			

All items related to environmental practices are assessed using a five point Likert scale (1 = not considering it, 2 = planning to consider it, 3 = considering it currently, 4 = carrying out to some degree, 5 = carrying it out fully); items related to performance are assessed on a five point Likert scale (1 = not at all, 2 = a little bit, 3 = to some degree, 4 = relatively strong, 5 = very significant)

*** p-value<.001, ** p-value<.01, — Fixed parameter for scaling purposes

Table 4 shows that the four first order GSCM practices are positively and significantly correlated. This suggests the presence of a higher order construct (which may better account for the variances) and that increasing the value of one GSCM component increases the value of another. We followed suggestions of Mishra and Shah (2009) by analyzing four measurement models using CFA. Model 1 conceptualizes that all 17 items for the GSCM practices are denoted by a single unidimensional factor. Model 2 conceptualizes that the 17 items are represented by four un-correlated first order factors (denoting the four sets of GSCM practices: EMSs, SR, ED and EEM). Model 3 conceptualizes that the four first order GSCM practices are allowed to freely correlate with each other, and Model 4 conceptualizes that the four first order factors of GSCM are modeled by a reflective second order factor representing the complementarities among the first order GSCM constructs.

Table 4: Correlation matrix and square root AVE of the constructs

1st order individual effect model

	EMSs	ED	SR	EEM	Sav	EnvI
EMSs	**0.735**					
ED	0.640	**0.755**				
SD	0.489	0.631	**0.762**			
EEM	0.551	0.542	0.570	**0.819**		
Sav	0.307	0.312	0.441	0.218	**0.787**	
EnvI	0.370	0.207	0.532	0.224	0.593	**0.812**
Mean	3.85	3.54	3.12	3.42	3.31	3.60
S.D	1.09	1.21	1.29	1.22	1.10	1.02

2nd order collective GSCM model

	EnvI	Sav	GSCM
EnvI	**0.812**		
Sav	0.655	**0.787**	
GSCM	0.393	0.388	**0.819**
Mean	3.60	3.31	3.49
S.D	1.02	1.10	1.20

Note: Square root of AVE on the diagonal
Correlation is significant at $p<.05$ for values greater than .155, at $p<.01$ for values greater than .220, at $p<.001$ for values greater than .334, N=138

The model fit results of the four measurement models (see Table 5) show that the fit measures for Model 2 are better than Model 1, suggesting that a multi-dimensional model involving the four distinct factors of GSCM practices is better than a single-unidimensional first order factor model. Further, the superior fit of Model 3 when compared to Model 2 is due to the strong correlations between the first order GSCM factors. These results already provide initial evidence that the collective GSCM competency is a higher order construct, and that the four GSCM dimensions complement each other. Finally, when comparing Model 3 and Model 4, we obtain identical results (as is the case in Mishra and Shah (2009)). In such case, the superiority between the models is decided by comparing the significance of the structural links between the second order factor model and the first order factors model. This is conducted in the following section.

Table 5: Measurement Models for GSCM practices

Models / Model fit results and recommended values	χ2 (df) NA	Normed χ2 , <3.0	GFI , ≥.8	CFI , ≥.9	IFI , ≥.9	RMSEA ,<.10	PCFI ,≥0.70
Model 1 (one-factor model)	316.3(90)	3.515	0.731	0.773	0.776	0.138	0.672
Model 2 (4 uncorrelated factors)	328.1(90)	3.650	0.741	0.774	0.777	0.135	0.663
Model 3 (4 correlated factors)	150.8(84)	1.79	0.871	0.936	0.938	0.076	0.749
Model 4 (1 2nd order factor)	150.8(84)	1.79	0.871	0.936	0.938	0.076	0.749

Model 1: when all items of the four GSCM practices are loaded on a single factor; Model 2: when items are allowed to freely load on their constructs of the four different GSCM practices; Model 3: when the first order GSCM practices are correlated; Model 4: when a second order factor represent the four first order GSCM factors.

4.2 Structural model analysis

4.2.1 Competing models assessment

We apply the statistical tests suggested by Venkatraman (1989) and used by Mishra and Shah (2009) to assess the superiority of second order, collective GSCM competency structural model. This model is superior if (1) it fits better than the first order model, and if (2) it explains the structural relationships between constructs better through a higher significance of the structural links.

Both models achieve an acceptable overall fit (Table 6), but the collective GSCM competency model achieves a better fit on all reported indices, which supports the complementarity of GSCM practices. Also, as shown in Table 6 (column 1) and Figure 3, in the individual effect model only four out of eight arcs from the individual environmental practices to environmental impact and environmental cost savings are significant ($p<.05$). This is not in line with the findings in previous studies and may reveal insufficient model specification. In contrast, all the links in the collective GSCM competency model (column 2) are significant and in the predicted directions, supporting Proposition P. The results of the correlation matrix of the constructs, the overall model fit, and the evaluation of size, direction and significance of structural path coefficients clearly show that the collective GSCM competency model explains the relationships and impacts of GSCM better. Therefore, we accept Proposition P and we use the collective GSCM competency model to test Hypotheses H1-3.

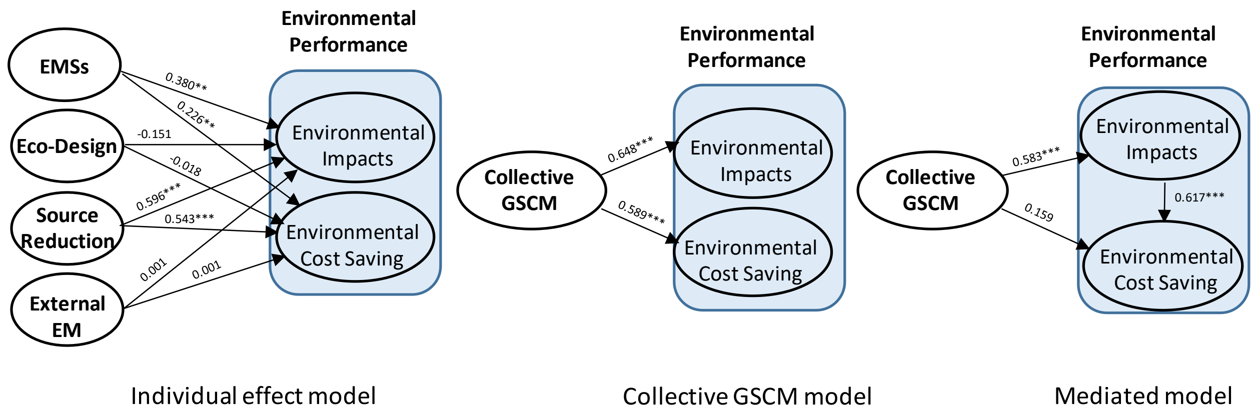

Figure 3: Results of the SEM

4.2.2 Hypotheses tests: Links between GSCM practices and performance

4.2.2.1 Direct effects

H1 states the collective GSCM competency is positively related to the firm's environmental impact or that a better collective GSCM competency leads to a larger reduction in environmental emissions. The positive and statistically significant coefficient (β= 0.648, p≤ .001) reported in Table 6, column 2 clearly supports this hypothesis. Likewise, the positive and statistically significant coefficient on the path collective 'GSCM competency → environmental cost savings' (β= 0.589, p≤.001) reveals that greater cost savings can be achieved by firms that focus more on developing the collective GSCM competency. Hence, we find support for both hypothesis H1 and H2.

4.2.2.2 Mediating role of environmental impact

We test the mediation effect following the approaches suggested by Baron and Kenny (1986), James *et al.* (2006) and Hopwood (2007). SEM is preferred in mediation tests compared to regression analysis because it allows for a holistic and simultaneous evaluation of the conceptual relationships and reduces the possibility of having type 1 errors in the score of the mediator variable.

In the collective GSCM competency model (Column 2, Table 6) the paths from the collective GSCM competency (independent variable) to environmental cost savings (dependent variable) and to environmental impacts (mediator) have positive and significant coefficients. We compare this model with an alternative model where a mediating link 'environmental impact → environmental cost savings' is added. The results of the mediation model are presented in column 3 of Table 6. Although the overall fit of the non-mediated collective GSCM competency model was acceptable (see fit indices in Table 6), the corresponding values for the mediated model are better. This indicates a better fit for the mediated model and provides initial support for H3.

Table 6: Results of structural equation modelling and goodness of fit

	Individual effect (1st order) model	Collective GSCM competency (2nd order) model	Mediated model
Structural paths			
EMS→environmental impact	0.380**		
EMS→ environmental cost savings	0.226**		
Eco-design→environmental impact	-0.151		
Eco-design → environmental cost savings	-0.018		
Source reduction→environmental impact	0.596***		
Source reduction → environmental cost savings	0.543***		
External EM→environmental impact	0.001		
External EM → environmental cost savings	0.001		
Collective GSCM → environmental impact		0.648***	0.563***
Collective GSCM → environmental cost savings		0.589***	0.159
Environmental impact→ environmental cost savings			0.617***
Control variables			
Size→environmental impact	0.241*	0.198*	0.106
Size→ environmental cost savings	0.102	0.041	0.112
Age→ environmental impact	0.162	0.110	0.104
Age→ environmental cost savings	0.144	0.124	0.079
Pollution Intensity→environmental impact	0.218*	0.201*	0.188*
Pollution Intensity → environmental cost savings	0.179*	0.150	0.127
Structural models goodness of fit results/ indices			
χ2 (df) , NA	775.83 (291)	600.43 (293)	503.51 (292)
Normed χ2 , <3.0	2.67	2.05	1.93
GFI , ≥.8	0.803	0.836	0.851
CFI , ≥.9	0.877	0.922	0.941
IFI , ≥.9	0.877	0.925	0.939
RMSEA ,<.10	0.110	0.080	0.073
PCFI ,≥0.70	0.639	0.713	0.758
(Hair et al., 2010)			

The results in Table 6 (column 3) further show that the influence of environmental impact on environmental cost savings is strongly significant and positive (β= 0.617, $p\leq$ .001). It also shows that after incorporating the mediated links to the model, the previously significant direct link between the collective GSCM competency and environmental cost savings has become insignificant (β= 0.159,

$p > .05$). Therefore, a full mediation effect of environmental impact on the influence of the collective GSCM competency on environmental cost savings is confirmed. Taken together, these results provide clear empirical evidence that the cost impact from the development of the collective GSCM competency is dependent on the level of environmental impact a firm achieves.

4.2.3 Control variables

None of the control variables (firm size, age, and industry pollution intensity) have a significant impact on environmental cost savings. Firm size and pollution intensity have marginal positive links with environmental impact suggesting that larger firms and firms operating in highly polluting sectors have (and tend to dedicate) more resources that enable them to better integrate their environmental efforts to achieve greater environmental outcomes. These links, however, are not significant in terms of firm age. The weak or insignificant impacts of the control variables may be due to the relative sample size in the specific subcategories.

5. Discussion of the results

Many existing studies consider isolated GSCM practices and lack a more holistic view. Our results show that the implementation of GSCM practices is a collective competency and that the impact of environmental practices is better understood when the different aspects of environmental management are treated as a single construct. The benefits obtained from the joint implementation of various environmental initiatives exceeds the total value obtained from adopting these practices separately. Shah and Ward (2003) argue that a bundle of resources (instead of an individual resource) developed inside the company can be a source of competitive advantage. Integrating different environmental practices may therefore enhance the competitiveness of the firm, which supports the complementarity theory of organizational activities and resources (Milgrom and Roberts, 1995).

Our findings are consistent with complementarity studies conducted in other contexts (Melville *et al.*, 2004; Cassiman and Veugelers, 2006; Mishra and Shah, 2009), and extend the complementarity theory to Environmental Management and across the supply chain, i.e., beyond internal practices (Inman and Green, 2018). Our results also link to the Natural Resource Based View proposed by Hart (1995), which argues that companies achieve competitive advantage through careful interaction with the natural environment (Li *et al.*, 2016). Hart (1995) discusses different environmental strategies and how they are largely interconnected, with a competitive advantage possibly only achieved if the strategies are overlapping, embedded and path dependent. Our results point in the same direction: simultaneous adoption of several interconnected GSCM practices enhances their individual performance impacts, thereby collectively creating better performance.

The empirical Middle East context also offers a theoretical contribution. We show that complementarity theory is possibly an *etic* theory, i.e., one that can be adopted in different contexts rather than a more local, culture-specific *emic* theory (Revilla and Sáenz, 2014). Complementarity theory thus applies also within an emerging market context, and collective competencies can be developed in companies operating in developing countries.

The findings of a strong and positive influence of the collective GSCM competency on both environmental impact and cost savings support findings in previous studies (e.g., Zhu and Sarkis, 2004), and show that proactive environmental management programs lead to reduced environmental impact and allow better business performance.

Further analysis revealed a mediation effect of environmental impact on the relationship between the collective GSCM competency and environmental cost savings. Thus, the collective GSCM competency can indirectly lead to better business benefits. With this finding we bring to the forefront the role of environmental improvement towards achieving maximum benefit from GSCM practices. This is a novel contribution to the existing GSCM literature because much has been done to examine the relationship between environmental practices and performance, yet no consensus has been reached (Zeng *et al*. 2010a). The use of the collective GSCM competency construct and the simultaneous consideration of both the direct and the mediated effects in this study may provide a more realistic picture of how environmental practices and business outcomes are related.

The lack of a significant direct relationship (in the mediated model) between the GSCM practices and environmental cost savings supports the findings of studies in other developing contexts such as China (Zhu and Sarkis, 2004; Zhu et al., 2008; Li, 2014). In contrast, Green et al. (2012 a & b) using a sample of more 'mature' U.S.-based manufacturing companies report direct performance effects from many - though not all - GSCM practices. Compared with Oman and other developing countries, manufacturing companies in more developed countries may be more sensitive to environmental problems. GSCM is a relatively new concept in developing countries (Zhu et al., 2005), and countries like Oman are still in the early stages of implementing proactive green practices, and local managers may face difficulties in developing these (Gavronski et al., 2011). The joint implementation of various GSCM practices requires high investments and it may take time before manufacturers realize more direct economic benefits. Longitudinal studies can confirm this (Gotschol et. al., 2014).

Our study is among the very first to explore GSCM practices in Gulf Cooperation Council (GCC) countries (Oman, U.A.E, Qatar, Kuwait, K.S.A, and Bahrain), and it was fully supported by the Omani government. Although there are some political differences between the GCC countries, these differences are not significant when it comes to environmental regulations. Growing international pressure and willingness to enhance environmental reputation have encouraged GCC governments to sign regional and international agreements to protect the environment (Raouf, 2008; Reiche, 2010). All GCC countries are active in terms of encouraging GSCM practices in manufacturing firms so that generalizability of our findings to the wider GCC region can be expected.

6. Conclusions and areas for further research

The interdependency of various GSCM initiatives has been ignored in most studies. Using survey data from Omani manufacturing firms and SEM, we find empirical support for a second order, collective GSCM competency construct, which integrates complementary internal and external proactive practices (Environmental Management Systems, Source Reduction, Eco-Design, and External Environmental Management). The collective GSCM construct provides a more complete understanding of how GSCM practices and business impacts are interrelated. We find a strong and positive influence of the collective GSCM competency on both environmental impact and environmental cost saving, and also a mediation effect of environmental impact on the relationship between the collective GSCM competency and environmental cost savings.

Our results bear implications for the current debate: does it pay to be green? GSCM practices work best when implemented together. Managers should therefore give equal attention to investments in both internal and external GSCM practices. Focusing on a single, or limited, set of environmental practices may jeopardize positive performance impacts. Developing a collective GSCM competency is particularly important for the manufacturers in developing counties (like Oman) that aim to improve their international reputation and enhance their attractiveness as a partner for Western firms. Our findings suggest that the improvement in environmental performance (emissions) is essential and a prerequisite for achieving greater levels of cost savings. The strategic nature of achieving good environmental performance in order to obtain greater business benefits should not be understated.

A comparison of our results in Oman with findings from previous studies in China and the U.S. further supports a strong, generalized conclusion about the relationship between environmental practices and business performance, and that, in emerging markets, environmental cost savings are achieved more indirectly.

Our work provides empirical support for the complementarity of environmental management initiatives, but it lacks the specificity about the main factors that cause these complementarity relationships to happen. Studying the influence of moderating and/or mediating factors may provide a better understanding of how context specific factors may cause positive or negative outcomes - an area which is largely missing in the existing complementarity theory literature. Our study supports the existing belief that GSCM practices can significantly enhance the environmental performance of a firm, but the main drivers for developing proactive practices are yet to be investigated. The development of the GSCM competency might be mainly derived from the pressure of a specific, more environmentally sensitive, stakeholder group. These stakeholder groups could differ from one context to another and accordingly lead to different performance outcomes. More studies in both developing and developed countries need to be conducted to determine the conditions, under which direct business benefits can be achieved. Future studies could also consider a dyadic buyer-supplier network as a unit of analysis, and this may provide a deeper understanding of how the supply chain members can affect a firm's ability to develop a sustainable GSCM capability.

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Appendix . Questionnaire

A- Company and Respondents' Identification Information
Company:………………………..Total No. of employees:……………….Years in Business:…….. Production:…………………………
B- Green Supply Chain Management Practices Implemented: Q.1 *Please assess the degree of development of the following activities in your company. Please use the following scores: 5 = carrying it out fully, 4 = carrying it out to some degree, 3 = considering it currently, 2 = planning to consider it, and 1 = not considering it.*
Q1.1 Using advance inventory management techniques Q1.2 Cross functional cooperation Q1.3 Providing ongoing support from top management Q1.4 Regular maintenance of the production equipment Q1.5 Providing training to employees/managers on various environmental management areas Q1.6 Including environmental considerations in selection criteria for suppliers Q1.7 Achieving environmental goals collectively with our main suppliers Q1.8 Providing suppliers with written environmental requirements for purchased items Q1.9 Providing customers with written environmental information related to our products Q1.10 Working with customers to develop a mutual understanding of responsibilities regarding environmental performance Q1.11 Conducting joint planning sessions, workshops and knowledge sharing activities with suppliers to anticipate and resolve environmental-related problems Q1.12 Redesigning the product or the production process Q1.13 Using packaging and pallets which can be reused Q1.14 Increase the life cycle of the product Q1.15 Use of recycled materials in production Q1.16 Reducing the variety of materials used in the production Q1.17 Avoidance of harmful materials or components
C- Environmental Impact and Environmental Cost Savings Q.2 *Please assess to what extent you think that implementing some or all of the above environmental practices have affected your firm's performance in the following ways. Please use the following scores: 1 = not at all, 2 = a little bit, 3 = to some degree, 4 = relatively strong, 5 = very significant*
Q2.1 Reducing consumption of harmful materials Q2.2Reduction of air emissions Q2.3 Reduction of water emissions Q2.4 Reduction of solid waste disposal Q2.5 Reduction of environmental accidents Q2.6 Decrease of fee for waste treatment Q2.7 Decrease of fee for waste discharge Q2.8 Decrease of cost for energy consumption Q2.9 Decrease of material purchasing costs