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# INFLUENCING FACTORS OF SHARING PRODUCT-RELATED ENVIRONMENTAL INFORMATION

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*Complete Research*

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## Abstract

*During the last decades, firms have deployed environmental sustainability practices. While most of these practices incur internally within a firm's boundaries, collaboration with supply chain partners and sharing of information related to the environmental impact of a firm's products and processes, namely environmental information, has been identified by many firms as essential in order to achieve their environmental and economic goals. In our research, we focus on a specific type of environmental information, the product-related one. We explore the factors influencing the sharing of product-related information, including the role of environmental collaboration, IT Infrastructure capabilities, supply chain integration capabilities and product-related information availability. A questionnaire-based survey is used targeting European firms in the fast moving consumer goods industry. The testing of the research model and hypotheses is performed using the Structural Equation Modelling (SEM) technique with Partial Least Squares (PLS). The results show that environmental collaboration, supply chain integration capability and product-related environmental information availability have a significant effect on sharing of product-related environmental information. However, IT integration capabilities appear not to be an important influencing factor.*

*Keywords: Product-related environmental information, supply chain integration capabilities, environmental collaboration, environmental information availability, environmental corporate strategy*

# 1 Introduction

As sustainability issues have come to the societal and governmental forefront (Watson et al., 2008), firms in the various industries start to feel the need to measure, improve and disclose their environmental performance under the pressure of both internal and external forces. International protocols and regulatory bodies pose formal requirements regarding environmental performance and supply chain partners and customers start demanding information about a firm's environmental performance. On top of the above external forces, firms need to remain competitive and sustainable in the global environment in terms of cost and dependence on physical resources. As a result, good environmental performance and a firm's ability to monitor and measure environmental impacts is a prerequisite not only for a firm’s good public image but for its economic survival as well.

In this context, the need for collecting correct, sufficient and understandable information regarding the environmental impact of production processes and products, called as environmental information, is more imperative than ever before (Preuss, 2005; Grankvist and Biel, 2006; Hult et al., 2007; Srivastava, 2007; Thun and Muller, 2008). Environmental information could both support firms to minimize their environmental impacts and to enhance environmental decision making processes (Soler et al, 2010) . Moreover, the sharing of environmental information among supply chain partners could enable an end-to-end information flow following a product life-cycle perspective.

In the environmental management, supply chain management and information systems literature, there is limited research regarding environmental information. These efforts focus on environmental information that is related either to a firm's processes or to products and indicatively examine ecolabelling issues (Fairweather et al., 2005; Rex and Baumann, 2007; Thøgersen et al., 2010) and the importance of environmental information for green purchases (Leire and Thidell, 2005). Moreover, there are some efforts that examine the disclosure of environmental information and some others that identify the environmental information gaps (Aschehoug et al., 2012) and highlight the importance of sharing environmental information (Brown et al., 2009; Sarkis, 2011, Sarkis, 2012).

From a firm's point of view, enterprises have implemented various environmental business practices to meet their environmental business objectives. However, there are only limited efforts on collecting, distributing and sharing environmental information. Firms mainly focus on measuring their processes' and products' environmental impacts within their scope. Measuring environmental impacts across a products life-cycle demands the interaction and collaboration of different supply chain partners, the availability of environmental information from all supply chain partners and also the necessary technological infrastructure and supply chain processes that would facilitate such sharing.

To facilitate the sharing of product-related environmental information across a supply chain, an understanding of the influencing factors is needed, so that a firm can determine the barriers preventing information sharing and design solutions to overcome them. In our paper, we focus on product-related environmental information and we explore the factors that may influence the sharing of this kind of information.

The paper is structured as follows: the next section draws upon extant theory to develop the research hypotheses; the following sections then discuss the research methodology, evaluate the psychometric properties of the various constructs used in the study and present the results. The concluding section provides a discussion of the results, implications for research and practice, and limitations of the study.

# 2 Background and research model

## 2.1 Sharing of product-related environmental information

During the last decades, firms have deployed various environmental sustainability practices. While most of these practices incur internally within a firm’s boundaries, firms have started to identify the need for monitoring and reducing the environmental impact of their processes and products across the supply chain which has brought the need for information sharing in the forefront (Preuss, 2005; Soler et al, 2010).

Information sharing has been a major research issue for many disciplines during the last decades (Cachon and Fisher, 2000; Clemons and Hitt, 2004; Kotabe et al., 2003; Patnayakuni et al., 2006; Raghunathan, 2001; Riggins et al., 1994). However, sharing of environmental information has not been discussed to a great extent. We distinguish two types of environmental information: the company-related and the product-related information. According to Erlandsson and Tillman (2009), "company-related information is defined as the environmental impact related to a company's own activities, primarily production processes". On the other hand, while a company is accountable for its products, "product-related environmental information often includes only a subset of a company's own activities. Above all, it includes the resource use and emissions of suppliers and customers." Moreover, environmental product information could be used either for enhancing internal processes, as environmental management and product design, or for external use, as reporting environmental performance and ecolabelling.

Previous research efforts have discussed the need of environmental information in relation with environmental reporting (Azzone et al., 1998; Gray et al., 1995; Kolk, 2008), environmental management systems (Melnyk et al., 2003; Morrow and Rondinelli, 2002; Steger, 2000) and ecolabelling (Fairweather et al., 2005; Rex and Baumann, 2007; Thøgersen et al., 2010),. Some researchers have addressed the issue of environmental information, and more specifically company-related environmental information, in the context of voluntary disclosing environmental information (Jenkins and Yakovleva, 2006; Liu and Anbumozhi, 2009).|Moreover, some other studies have examined the role of environmental information, more specifically the product-related one, for supporting innovation processes (Foster and Green, 2000), green product design (Aschehoug et al., 2012; Nakano and Hirao, 2011) and product stewardship (Sarkis, 2012).

However, most of these efforts focus on company-related and product-related environmental information for internal use. Sarkis et al., (2012) identify the lack of environmental information at product level, as firms don't have the full knowledge of their products and materials flow across the supply chain, and discuss the need for information sharing. Sharing of environmental information has also been identified as a major barrier to the implementation of environmental practices and technology (Vachon and Klassen, 2006a, b) and is critical for collaborative initiatives in order to gain sustainable competitive advantage and improve environmental performance (Solér et al., 2010).

Taken into account the aforementioned research gaps, in this study we focus on the sharing of product-related environmental information among supply chain partners in order to support collaborative practices, such as carbon-footprint-monitoring across the supply chain, collaborative product design, collaborative distribution. Various environmental indicators have been developed in order to measure environmental impacts (Herva et al., 2011). However, carbon emissions and energy consumption (e.g. electricity or fuel consumption) are the most prevalent ones for measuring environmental impacts at product level. Thus, in our study the product related information includes information regarding carbon emissions and energy consumption.

Moreover, in this study we investigate the factors that may affect the sharing of product-related environmental information among supply chain partners. Numerous research efforts in different research areas, such as management, supply chain management and information systems, have investigated the factors that motivate companies to configure environmental strategies, apply environmental practices and adopt IS-enabled environmental solutions or drive a company's environmental proactivity (Banerjee et al., 2003; Bansal, 2002; González-Benito and González-Benito, 2006). Some of these factors depict internal company features e.g. environmental strategy, competive advantage (Banerjee et al., 2003), technological maturity (Jenkin et al., 2011) and others describe the general environment in which operations are carried out (e.g. legislation, stakeholder pressures, public concern) (Fraj-Andrés et al., 2009; Delmas and Toffel, 2004).

When looking specifically at factors influencing the sharing and disclosure of environmental information, we can identify some studies investigating the role of stakeholder pressures (Brammer and Pavelin,2008; Liu and Anbumozhi, 2009) and information quality (Mogensen and Holbech,2007) to environmental information disclosure. Soler et al., (2010) examine how perceived environmental cost and perceived environmentally informed consumer demand affect the sharing of environmental information by using a stage-dependent approach. Erlandsson and Tillman (2009) propose a theoretical framework for exploring the factors that affect corporate environmental information management including the collection, management and communication of environmental information.

The previous studies have mainly examined the role of stakeholders, consumer demand, top-management environmental commitmentand perceived cost as factors influencing the disclosure of environmental information. However, they mostly focus on one-way disclosure of information rather than on the sharing of environmental information among supply chain partners. When we consider the sharing of environmental information, then collaboration and a close relationship between supply chain partners comes to the forefront (Bowen et al., 2001; Moberg et al., 2002). Moreover, IT integration capabilities (Bowersox et al., 1999, Clemons and Row, 1992; Kim et al., 2006; Lewis and Talalayevsky, 1997), and information quality and availability (Moberg et al.,2002; Erlandsson and Tillman, 2009) have been identified as important prerequisites.

In this study we specifically look at how collaboration on environmental issues, IT integration and supply chain process integration capabilities and the availability of product-related environmental information affect the sharing of environmental information among supply chain partners. In the following sections and based on the pertinent literature we formulate hypotheses on the factors that may affect the sharing of product-related environmental information.

## 2.2 Environmental collaboration

Collaboration with partners in the supply chain could enable and facilitate the application of environmental practices (Green et al., 1996; Lamming and Hampson, 1996) and the management of environmental issues (Noci, 1997). Florida (1996) showed that close relationships across the production chain, between end-users and suppliers in particular, facilitate the adoption of environmental and industrial innovations. Cooperation can enhance learning between buyers and suppliers and support the implementation of cooperative recycling strategies as Den Hond (1996) showed. It could also facilitate the communication and the information exchange between supply chain partners and the development of confident interorganizational relationships in order to aid in the implementation of environmental goals (Bowen et al., 2001). Thus, collaboration could facilitate the implementation of environmental practices in the supply chain and enhance the common understanding of the environmental impacts of each other activities (Bowen et al., 2001).

Based on the above, collaboration is positively related to sharing of product-related environmental information. However, in our context, we consider that collaboration on addressing specific environmental issues and not collaboration in general is more relevant and could be more related to information sharing. We think that collaboration on environmental issues imposes supply chain partners interest on environmental issues and their willing to address these issues collaboratively. In this context, sharing of product-related environmental information could be another environmental practice or a means for enabling the implementation of various environmental practices in the broader scope of the supply chain. Moreover, collaboration on environmental issues could be a first step towards the sharing of environmental information.

Collaboration for confronting and handling environmental issues has been indirectly discussed in many previous research efforts (Florida, 1996; Geffen and Rothenberg, 2000; Rao, 2002). However, only recently the term "environmental collaboration" was introduced to conceptualize it. According to Wassmer et al., (2012), environmental collaborations in an interfirm level are "voluntary collaborations between two or more firms involving the exchange, sharing, or co developing of resources and capabilities as part of a project or business operation (Dussauge et al., 2000; Gulati, 1999)". On the other hand, Vachon and Klassen (2006a) provide another definition which describes specific activities that are conducted with the collaboration of two supply chain partners. According to them, environmental collaboration includes "activities that comprise a direct involvement of the buying organization with its suppliers to jointly develop environmental solutions". These activities include achieving environmental goals collectively, developing a mutual understanding of responsibilities regarding environmental performance, working together to reduce environmental impact of activities and making joint decisions about ways to reduce overall environmental impact of product.

Based on the above, we formulate the following hypothesis:

H1: Environmental collaboration is positively related to the sharing of product-related environmental information

Moreover, many research efforts have investigated the role of environmental strategies in applying environmental practices (González-Benito and González-Benito, 2006; Teixeira, 2011), green information systems implementation (Jenkin et al., 2011), green supply chain practices (Chan, et al., 2011) and environmental sustainable development (Bansal and Hunter, 2003; Shrivastava, 1995). Besides, firms that have developed environmental strategies and have aligned their actions to these strategies are more likely to engage their partners in order to obtain the necessary resources and succeed in their environmental goals (Aragón-Correa, 1998; Aragón-Correa and Sharma, 2003; Sharma, 2000). However, the influence of environmental strategy on a firm’s engagement to environmental collaboration has not been studied explicitly (Wassmer et al., 2012). According to Banerjee et al., (2002), the environmental corporate strategy involves integration of environmental issues into the strategic planning process. This is done by establishing a link between environmental objectives and other corporate goals and by incorporating environmental issues in a firm's processes e.g. on developing new products. As the development of new collaboration relationships consists a strategic decision, collaboration on addressing environmental issues could be another way of integrating environmental issues into a firm's strategic planning process. We consider that a firm's decision to collaborate on environmental issues precedes the decision to share environmental information.

Thus, we formulate the following hypothesis:

H2: Environmental corporate strategies is positively related to environmental collaboration

Moreover, Wassmer et al., (2012), highlights the fact that environmental collaboration should be treated as an element of a collaboration portfolio and a firm's engagement in multiple simultaneous collaborations and the existing collaboration could play an important role into the establishment of new collaborations (Wassmer, 2010; Wassmer and Dussauge, 2011). Thus, we will also explore the effect of the existing level of collaboration on a firm's engagement to environmental collaboration and we formulate the following hypotheses:

H3: Collaboration positively is positively related to environmental collaboration

## 2.3 IT integration and supply chain integration capabilities

The implementation of interorganizational links and the exchange of information is usually a demanding process in terms of resources and expertise. Information technology has played an important role in enabling the development of interorganizational relationships and supply chain management processes by integrating various information flows and processes and enhancing the seamless information flows (Frohlich and Westbrook, 2001; Gunasekaran and Ngai, 2004; Kim et al., 2006; Wu et al., 2006). Previous studies have discussed the importance of interorganizational integration capabilities on information sharing (Rai et al., 2006; Riggins et al., 1994) supply chain management and interorganizational relationships (Saraf et al., 2007). It has been shown that interfirm systems integration positively affects information exchange (Kim et al., 2006; Wu et al., 2006; Jean et al., 2008) and that closer systems integration could enhance information exchange activities (Stank et al., 1999). Moreover, earlier efforts have also discussed the enabling role of IT integration capability on the process capabilities which are required in order to handle interorganizational relationships (Grover and Saeed, 2007; Rai and Tang, 2010).

Therefore, in this study, we consider that a firm's supply chain management integration capabilities are important for sharing product-related environmental information and we use the two supply chain management integration capabilities proposed by Rai et al. (2006): IT Infrastructure Integration Capability and Supply Chain Process Integration Capability.

Rai et al. (2006) define IT infrastructure integration capability as "the degree to which a focal firm has established information systems for the consistent and high-velocity transfer of supply chain-related information within and across its boundaries." They define IT infrastructure integration capability as a formative construct that is consisted of two subconstructs, data consistency, that refers to "the degree to which common data definitions and consistency in stored data have been established across a focal firm's supply chain" and cross-functional SCM application systems integration that refers to "the degree of real-time communication of a focal firm's function-specific supply chain management applications with each other and related ERP and CRM applications." Within a distributed supply chain context, where various partners have implemented their own information systems, there are major inconsistency problems in data definition and format (Van Den Hoven, 2004 ). The lack of consistency could affect the quality of environmental information and provide corrupted or inaccurate information to various partners across the supply chain. The communication among the supply chain management applications of the various partners imposes the existence of data interfaces that will enable seamless information flows. Moreover, the integration on application systems level enables firms to manage cross-functional processes (Rai, Bush, and Tiwana, 2002; Rai, Ruppel, and Lewis, 2002), coordinate internal with external processes and also succeed visibility across supply chain.

Supply Chain Process Integration Capability is defined as "the degree to which a focal firm has integrated its physical, financial, and information flows with its supply chain partners" (Rai et al., 2006). This is also defined as a formative construct that is consisted of three subconstructs: Physical Flow Integration, that refers to "the degree to which a focal firm uses global optimization with its supply chain partners to manage the stocking and flow of materials and finished goods", Information Flow Integration, that refers to "the extent of operational, tactical, and strategic information sharing that occurs between a focal firm and its supply chain partners" and Financial Flow Integration, that refers to "the degree to which financial flows between a focal firm and its supply chain partners is driven by workflow events." In this study, we specifically focus on information at the product level, thus the ability to monitor flows of both materials and finished goods is important. Based on the pertinent literature, Physical Flow Integration could bring various benefits to firms such as cost savings due to better management of production, transportation, and warehousing processes (Goldhar and Lei, 1991; Schneidrjans, 1993), improved material handling and collaboration with reliable suppliers (Schneidrjans, 1993). The aforementioned benefits could be extended to include environmental related benefits as improvement of environmental performance both at company and product level by managing production, transportation, and warehousing processes and improving material handling. Information flow integration specifies a firm's current level of exchanging various types of information as key performance indicators, inventories, sales, production and delivery schedules. This also imposes that a firm has established processes for exchanging information and that it could possibly be able to expand the types of information exchanged by including environmental information. Thus, in the specific research context, both Physical and Information Flow Integration were considered as important dimensions that could affect the sharing of product-related information. On the other hand, we don't consider that integrated financial flows are relevant to the context of environmental information, as this type of information is not related to financial issues as it happens with the case of orders, inventories and sales. Moreover, financial flow integration did not have significant formative weight for the supply chain process integration constructs in the study of Rai et al.,(2006) were it was first introduced.

Based on the above, we formulate the following hypotheses:

H.4: IT Infrastructure Integration positively is positively related to the sharing of environmental information

H.5: Supply Chain Process Integration is positively related to the sharing of environmental information

## 2.4 Product-related environmental information availability

During the last decades, firms have started to share information with their supply chain partners in order to access information and knowledge that was previous only accessible to one of them and reap the benefits of holding this knowledge (Clemons and Row, 1992; Lee et al., 2000; Lee, 200; Yu et al, 2001). Based on the nature and level of information sharing, they used to share e.g. inventories, orders, deliveries, sales, demand forecasts, order status, and production schedules (Seidman and Sundararajan, 1997). In contrast to the aforementioned types of strategic or operational information, environmental information does not simply exist in a firm's information systems and is not always recorded and available by various supply chain partners. It needs to "to be collected, compiled, and disseminated" (Erlandsson and Tillman, 2009). Currently, many of the products that are distributed across the supply chain don't carry any information about their environmental impact or the environmental information is available up to a specific point in the supply chain. Thus, sharing of environmental information has also to confront the informational boundaries that exist and which are related to the actual availability of information (Sarkis, 2012).

This boundary of information availability appears as many firms have not yet implemented a procedure in order to quantify the environmental impacts of their products in the narrow scope of their control. The most prevalent quantitative approach for measuring the environmental impacts at product level is LCA) and environmentally extended input-output (EEIO) models. LCA results could be a reliable piece of product-related environmental information that could be shared with other partners according to ISO 14044. Thus, we consider that firms that apply LCA methodologies or environmentally extended input-output (EEIO) models hold and can share product-related environmental information. Thus, we formulate the following hypothesis:

H6: The availability of product-related environmental information is positively related to the sharing of product-related environmental information.

Figure 1 shows the research model of the study.

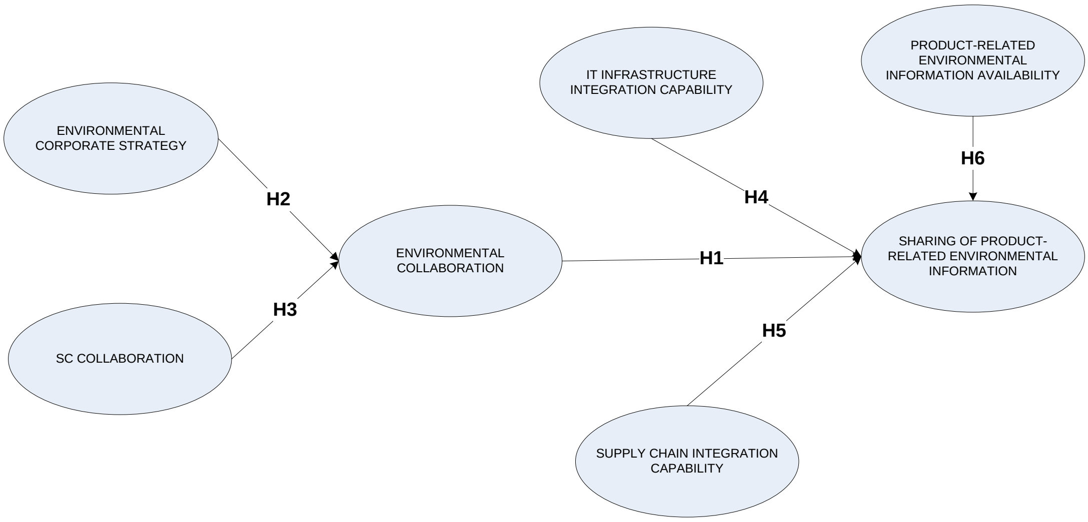


*Figure 1. The research model*

## 3 Research methodology

To investigate the determinant factors that influence a firm's decision to share environmental information and test our research hypotheses, a survey approach was followed, using the firm as unit of analysis. A detailed questionnaire has been used as research instrument. The survey ran for firms in the Fast-Moving Consumer Goods (FMCG) industry. We chose to focus on this industry due to the extensive collaborative initiatives that take place between suppliers and retailers in this sector and their interest in addressing various environmental issues. Target respondents were senior managers or middle managers with direct responsibility for environmental issues. In case there was no person in the organization devoted to environmental management, target respondents were senior managers or middle managers with direct responsibility for supply chain management or logistics.

The survey was conducted at European level and was supported by the Efficient Consumer Response (ECR) Europe organization. ECR Europe is a joint trade and industry body, launched in 1994 to make the FMCG sector as a whole more responsive to consumer demand and promote the removal of unnecessary costs from the supply chain. To collect the required data, an email invitation was sent by ECR Europe to all its member organizations across Europe, inviting target respondents to participate to the survey. To encourage participation, it was communicated that the results of the survey would be provided to each participant at the end of the survey. Each company was asked to respond only once to the online questionnaire.

To analyse the questionnaire data, examine the research model and test the hypotheses, a variety of analytic techniques and tools was used. SPSS software was used to organise the data and run preliminary descriptive analyses. The examination of the research model and the hypotheses testing was performed using the Structural Equation Modelling (SEM) technique using Partial Least Squares (PLS). PLS was chosen as it is more appropriate than LISREL-type models when sample sizes are small, models are complex and the goal of the research is in explaining variance (Smith and Barclay, 1997). PLS estimation makes no distributional assumptions about the sample data. Therefore, for concluding on the significance of parameters estimated bootstrap estimates of standard errors were utilized (White et al., 2003).

## 3.1 Data collection and sample

To collect the required data, a sample population was obtained from the ECR Europe members list. A total of 71 valid questionnaires have been collected. The survey ran from March 2012 to June 2012. The response rate varied in the different European countries and ranged from 12% to 50% (in Greece).

## 3.2 Measures

The measures employed in the present study have been adapted from the extant literature. Environmental Corporate Strategy was measured with two items and the responses were given on a seven-point Likert-type scale with the endpoints Strongly Disagree (1) and Strongly Agree (7) (Banerjee et al., 2003). Similarly, the Supply Chain Collaboration was measured with four items and the responses were given on a seven-point Likert-type scale with the endpoints Never (1) and Always (7) (Vachon and Klassen, 2006). The IT Integration Capability and the Process Integration Capability were measured with three items each (Rai et al., 2006), while the Environmental Collaboration was measured with four items respectively (Vachon and Klassen, 2006). In section 2.4, we analyzed why we could assume that the level of implementing LCA methodologies or environmentally extended input-output (EEIO) models could express the level of Environmental Information Availability. Thus, we considered that we could measure the Environmental Information Availability by measuring the extent of using LCA methodologies or environmentally extended input-output (EEIO) models. We used two items, respectively, and the responses were given on a seven-point Likert-type scale with the endpoints being "We know little about this practice" (1) and "We do this all the time" (7). Finally, as there is no measure employed in the literature for the construct of sharing product-related environmental information, we used the following items, based on the definition of the construct: "Receiving information about the carbon emissions / energy consumption of raw materials or products from suppliers", and "Providing information about the carbon emissions / energy consumption of produced products to supply chain partners". A seven-point Likert-type scale with the endpoints Not at all (1) and Great Extent (7) was used. The constructs and the respective items used for measurement are presented in Table 2 (Appendix) .The small number of indicators used for each construct could be a limitation of our study. However, the satisfactory levels of measurement validity and internal consistency, that results have shown, alleviate this limitation. Moreover, the scenario and survey procedure we have followed calls for parsimonious measurement scales in order to avoid respondents' fatigue.

# 4 Results

A structural equation modelling approach was used to measure the relationships proposed by our research model. This method was applied as it tests structural and measurement models and provides a complete analysis for interrelationships in a model. A variance-based partial least squares (PLS) method was chosen over covariance-based methods, such as LISREL, as it supports both exploratory and confirmatory research. The SmartPLS software was used (Ringle et al., 2005). PLS does not generate an overall goodness-of-fit index (as with LISREL), so model validity is assessed by examining structural paths and R2 values. Bootstrapping was performed to test statistical significance of each path coefficient using t-tests. We estimated the significance of the parameters on the basis of 1000 bootstrapped samples (White et al., 2003). Descriptive statistics of the constructs are shown in Table 1.

| Constructs | Descriptive Statistics | |
|---|---|---|
| | Mean | Standard Deviation |
| Environmental_Corporate_Strategy | 5.21 | 1.49 |

| | | |
|---|---|---|
| SC_Collaboration | 5.04 | 1.43 |
| Environmental_Collaboration | 3.55 | 1.76 |
| Data_Consistency | 5.81 | 1.71 |
| Cross_Functional_Application_Integration | 5.85 | 1.57 |
| Information_Flow_Integration | 5.06 | 1.60 |
| Physical_Flow_Integration | 5.48 | 1.60 |
| Product_related_environmental_information_availability | 2.86 | 1.92 |
| Sharing_of_product_related_environmental_information | 2.82 | 1.84 |

*Table 1: Descriptive Statistics*

## 4.1 Assessment of measures

Prior to any model examination or hypothesis testing we should ensure the validity of the measurement model. We tested our measurements for internal consistency, convergent and discriminant validity, employing the testing system recommended by Fornell and Larcker (1981). Internal consistency of our constructs is acceptable, as all the reliabilities – as measured by Cronbach's a indicator – exceed the 0.70 guideline that Nunnally (1978) recommends.

Convergent validity assures that all the measures measure a specific construct and the convergent validity of each construct is shown when all the measures of a certain construct correlate. Convergent validity can be assessed by a) reliabilities of items in each scale, b) the composite reliability of each construct and c) Average Variance Extracted (AVE). Reliability of items is assessed by examining each item's loading on its construct. As shown in Table 2 (see Appendix), all the items exceed the 0,60 recommended thresholds for exploratory research (Nunnally, 1978) and most of them exceed 0.90. Composite reliability assesses the internal consistency of a measure and is a measure of the overall reliability of a collection of heterogeneous but similar items. The composite reliability of every construct should exceed the 0.70 threshold (Hair et al., 1998). Average Variance Extracted assesses the variance the magnitudes of variance that a variable captures from its indicators compared to the amount that results from measurement error. The AVE of each construct is recommended to exceeds 0,50 (Fornell and Larcker, 1981). As shown in Table 3, all constructs have exceeded the thresholds of both composite reliability and AVE.

Discriminant validity is concerned with the discrimination among measures of different constructs. Discriminant validity is shown when the PLS indicators (a) load much higher on their hypothesised factor than on other factors (own-loadings are higher than cross-loadings), and (b) when the square root of each factor's Average Variance Extracted (AVE) is larger than its correlations with other factors (Gefen and Straub, 2005). As shown in Table 3 and Table 4 (Appendix) results support that there is discriminant validity, according to the test of Fornell and Larcker (1981).

## 4.2 Structural model

In PLS, the strength and the significance (or insignificance) of each structural path or hypothesis can be examined. PLS calculates a path coefficient or a beta value (β) which indicates the strength of the path and signifies the unique contribution that the independent variable makes in explaining the variance in the dependent variable. In addition, in PLS the statistical significance (or insignificance) of each hypothesis or path can be examined by applying a bootstrapping analysis. Figure 2 presents the results of the PLS path analysis (path coefficients (PC), T-values and R2 )

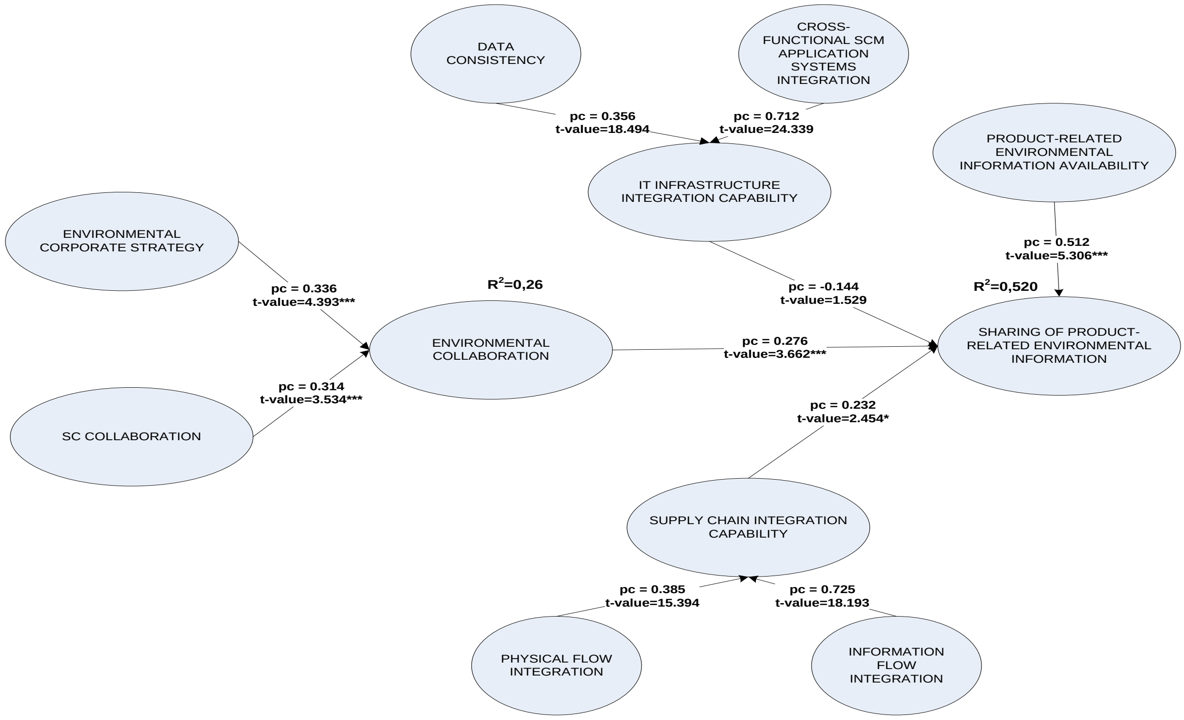


*Figure 2. PLS structural model*

*Note: *P<0.05, ***P<0.001*

All but one causal paths are significant at the 0.05 or 0.001 level. The hypotheses that link Environmental Corporate Strategy and Supply Chain Collaboration with Environmental Collaboration (H2 and H3 respectively) are supported and approximately 26% of the variance of Environmental Collaboration is captured by the variables in the model. Moreover, Environmental Collaboration, Product-Related Environmental Availability and Process Integration Capability are related to Sharing of Product-Related Environmental Information and the Hypotheses H1, H5 and H6 are supported. However, the hypothesis that link IT Integration Capability with Sharing of Product-Related Environmental Information (H4) is not supported. Besides, 52% of the variance of Sharing Product-Related Environmental Information is captured by the factors that are included in the model. Before trying to explain the reasons behind this outcome and the implications of the hypotheses testing results, this section first looked at the overall study results from a broader perspective.

# 5 Discussion

This paper has introduced the concept of sharing product-related environmental information and some interorganizational and intraorganizational factors that may affect it have been examined. Furthermore, the environmental collaboration is a central issue in the environmental management and in this study and the effect of environmental corporate strategy and the existing level of supply chain collaboration on it has been investigated. Moreover, issues related to the availability of product-related environmental information and its quality level in order to be used for operational or strategic decisions have been explored and discussed.

A primary outcome of this study, as presented through the descriptive statistics (Table 1), is that it depicts the current status of firms regarding various environmental management issues, as environmental collaboration and sharing of environmental information, that have raised great interest in the last years. Based on the results, firms have recognised the importance of environmental issues and they have incorporated them into their strategies to some extent. However, the alignment of corporate environmental consciousness with corporate strategy is still an open issue for many firms and a lot of efforts should be done for its implementation. Despite the fact that the importance of addressing environmental issues in a collaborative way has been recognised and discussed, firms have not yet been engaged in collaborative relationships regarding environmental issues. Moreover, results indicates that sharing of product related environmental information has taken place to a very limited extent. Based on the above, firms appear to treat environmental issues in the narrow scope of their control. Furthermore, regarding the environmental information, firms make various efforts in order to collect information regarding their environmental impacts. However, most of them are related to measuring the energy consumption or carbon footprint of the various company processes and not related to the specific products they produce or distribute. Results show that firms use environmentally extended input-output (EEIO) models and execute life cycle assessment studies on own products to a limited extent and some of them don't know a lot about these practices.

The results confirm the research hypotheses regarding the effect of environmental corporate strategy and supply chain collaboration on environmental collaboration. As it was expected, firms that have established an environmental corporate strategy and have been engaged in various environmental activities is more possible to initiate collaboration on environmental issues and engage themselves in environmental collaboration relationships. Even though, the aforementioned statement seems to be obvious, there is little empirical research that explores it. Regarding the effect of the existing level of collaboration in the context of supply chain, it could imply on the one hand a firm's collaborative culture and its strategy on developing collaborations and on the other hand its readiness, its resources availability and its capabilities on treating the development of interorganizational relationships. A firm that has already been engaged in various collaborations it would be probably easier to develop new ones related to environmental issues. Moreover, the perception that environmental collaboration should be treated as part of a collaboration portfolio is supported.

The environmental collaboration, the supply chain integration capability and the product-related environmental information availability have been found to have a significant effect on sharing of product-related environmental information and the largest effect comes from environmental collaboration and the product-related environmental information availability. As sharing of product-related environmental information is still in a nurture phase, ensuring that environmental information is available in a format and in a quality that could feed other processes is perceived as more important than the existence of capabilities that will enhance the implementation of this practice. In the same way, the development of environmental collaborations is also perceived as more important in this context. Even though the extant literature discusses the enabling role of IT on information sharing, IT infrastructure integration capability did not have a significant effect in comparison to other factors. A potential explanation for this may be that IT infrastructure integration capability was perceived as a lower-order technology capability that is used in order to enable supply chain process integration and thus, its effect is considered to be materialized through supply chain integration capabilities.

All-in-all, this research contributes to the IS literature in three-ways: (1) it introduces the concept of sharing of product related environmental information and also discusses the under researched concept of environmental collaboration; (2) it develops and empirically tests a conceptual model that includes interorganizational and intraorganizational factors that affect the sharing of product-related environmental information, and (3) it discusses and empirically tests the effect of environmental corporate strategy and the existing level of supply chain collaboration on the development of environmental collaboration relationships and also the role of integration capabilities on sharing of environmental information

Overall, this research is an important extension to the literature, because the discussion regarding the sharing of product-related environmental information and environmental collaboration is still limited and the factors that may affect it have not yet been fully considered.

## 6 Limitations and future research

This research has several limitations but these limitations offer opportunities for further research. Although this study helps to identify influencing factors of sharing product-related environmental information, the factors that are examined are not exhaustive. Moreover, this study examined only a limited set of constructs affecting environmental collaboration. Besides, the study was executed in a relatively limited context, that of the fast-moving consumer goods industry, which on one hand may affect the generalization of our findings but on the other hand it could give us a valuable insight in a sector which is more mature than other sectors regarding environmental issues and the deployment of various environmental practices and activities. In addition, social desirability bias is a common limitation in studies that try to investigate environmental issues. Social desirability bias was addressed by ensuring anonymity for all respondents. Last but not least, sharing of product-related environmental information and product-related environmental information availability were not measured by adopting already developed items and constructs. However, before constructing an empirically derived measure for a concept, it is necessary to theoretically define it and provide an empirical proof of its value which has been the aim of this research.

Future research can proceed in several directions. We could explore more influencing factors on sharing of product-related environmental information as institutional pressures, stakeholder pressures, company features, top management commitment. We could also further investigate the concept of environmental collaboration, identify different types of environmental collaboration and explore the factors that influence the various types of environmental collaboration relationships. We could also expand our sample in order to include firms from more countries so as to capture any cross-country differences. The proposed model could be tested in different industries in order to investigate any differentiations due to the industry type. As the issues discussed in this study have raised great interest in the last years, the survey could be conducted again in the next few years in order to develop more insights into the evolvement of firms' activities on these issues and draw conclusions based on longitudinal observations.

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## References

Aragón-Correa, J. A. (1998). Strategic Proactivity and Firm Approach to the Natural Environment. The Academy of Management Journal, 41(5), 556–567. doi:10.2307/256942

Aragón-Correa, J. A. and Sharma, S. (2003). A contingent resource-based view of proactive environmental strategy. Academy of Management Review, 28, 71-88.

Aschehoug, S. H., Boks, C. and Støren, S. (2012). Environmental information from stakeholders supporting product development. Journal of Cleaner Production, 31(0), 1–13. doi:10.1016/j.jclepro.2012.02.031

Azzone, G., Manzini, R. and Noci, G. (1998). Evolutionary trends in environmental reporting. Business Strategy and the Environment, 5(4), 219–230.

Banerjee, S.B. (2002). Corporate environmentalism: The construct and its measurement. Journal of Business Research, 55(3), 177-191.

Banerjee, S.B., Iyer, E. S. and Kashyap, R. K. (2003). Corporate environmentalism: Antecedents and influence of industry type. Journal of Marketing, 67(2), 106-122.

Bansal, P. (2002). The corporate challenges of sustainable development. Academy of Management Executive, 16, 122−131.

Bansal, P. and Hunter, T. (2003). Strategic Explanations for the Early Adoption of ISO 14001. Journal of Business Ethics, 46(3), 289–299.

Bowen, F. E., Cousins, P. D., Lamming, R. C. and FARUKT, A. C. (2001). The role of supply management capabilities in green supply. Production and operations management, 10(2), 174–189.

Bowersox, D. J., Closs, D. J., Stank, T. P. and University, M. S. (1999). 21st Century Logistics: Making Supply chain Integration a Reality. Council of Logistics Management.

Brammer, S. and Pavelin, S. (2008). Factors influencing the quality of corporate environmental disclosure. Business Strategy and the Environment, 17(2), 120–136. doi:10.1002/bse.506

Brown, H. S., de Jong, M. and Levy, D. L. (2009). Building institutions based on information disclosure: lessons from GRI's sustainability reporting. Journal of Cleaner Production, 17(6), 571–580.

Cachon, G. P. and Fisher, M. (2000). Supply Chain Inventory Management and the Value of Shared Information. Management Science, 46(8), 1032.

Chan, R. Y. K., He, H., Chan, H. K. and Wang, W. Y. C. (2012). Environmental orientation and corporate performance: The mediation mechanism of green supply chain management and moderating effect of competitive intensity. Industrial Marketing Management, 41(4), 621–630. doi:10.1016/j.indmarman.2012.04.009

Clemons, E. K. and Hitt, L. M. (2004). Poaching and the Misappropriation of Information: Transaction Risks of Information Exchange. Journal of Management Information Systems, 21(2), 87–107.

Clemons, E. K. and Row, M. C. (1992). Information technology and industrial cooperation: the changing economics of coordination and ownership. Journal of Management Information Systems, 9–28.
Clemons, E. K. and Row, M. C. (1992). Information technology and industrial cooperation: the changing economics of coordination and ownership. Journal of Management Information Systems, 9–28.
Delmas, M. and Toffel, M. W. (2004). Stakeholders and environmental management practices: An institutional framework. Business Strategy and the Environment, 13(4), 209–222.\

Den Hond, F. (1996). Capabilities in Corporate Environmental Strategy: The Case of End-of-Life Vehicle Recycling. Paper presented at the annual meeting of Academy of Management, Cincinnati, OH.

Dussauge, P., Garrette, B. and Mitchell, W. (2000). Learning from competing partners: outcomes and durations of scale and link alliances in Europe, North America and Asia. Strategic management journal, 21(2), 99–126.

Erlandsson, J. and Tillman, A. M. (2009). Analysing influencing factors of corporate environmental information collection, management and communication. Journal of Cleaner Production, 17(9), 800–810.

Fairweather, J. R., Maslin, C. and Simmons, D. G. (2005). Environmental values and response to ecolabels among international visitors to New Zealand. Journal of Sustainable Tourism, 13(1), 82–98.

Florida, R. (1996). Lean and green: the move to environmentally conscious manufacturing. California management review, 39(1), 80–105.

Fornell, C and Larcker, DF (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research 18(1), 39–50.

Foster, C. and Green, K. (2000). Greening the innovation process. Business Strategy and the Environment, 9(5), 287–303.

Fraj-Andrés, E., Martínez-Salinas, E. and Matute-Vallejo, J. (2009). Factors affecting corporate environmental strategy in Spanish industrial firms. Business Strategy and the Environment (John Wiley and Sons, Inc), 18(8), 500-514. doi:10.1002/bse.611.

Frohlich, M. T. and Westbrook, R. (2001). Arcs of integration: an international study of supply chain strategies. Journal of Operations Management, 19(2), 185–200. doi:10.1016/S0272-6963(00)00055-3

Gefen, D. and Straub, D. (2005). A practical guide to factorial validity using PLS-graph: tutorial and annotated example. Communications of the AIS, 16, 91–109.

Geffen, C.A. and Rothenberg, S. (2000). Suppliers and environmental innovation: the automotive paint process . International Journal of Operations and Production Management, 20 (2),166-86.

Goldhar, J. D. and Lei, D. (1991). The shape of twenty-first century global manufacturing. The Journal of Business Strategy, 12(2), 37–41.

González-Benito, J. and González-Benito, Ó. (2006). A review of determinant factors of environmental proactivity. Business Strategy and the Environment, 15(2), 87-102.

Grankvist, G. and Biel, A. (2006). The impact of environmental information on professional purchasers' choice of products, Business Strategy and the Environment, 16, 421–429.

Gray, R., Kouhy, R. and Lavers, S. (1995). Corporate social and environmental reporting: a review of the literature and a longitudinal study of UK disclosure. Accounting, Auditing & Accountability Journal, 8(2), 47–77. doi:10.1108/09513579510146996

Green, K., Morton, B. and New, S. (1996). Purchasing and Environmental Management: Interactions, Policies and Opportunities, Business Strategy and the Environment, 5, 188–197.

Grover, V. and Saeed, K. A. (2007). The impact of product, market, and relationship characteristics on interorganizational system integration in manufacturer–supplier dyads. J. Management Inform. System s, 23(4), 185–216.

Gulati, R. (1999). Network location and learning: the influence of network resources and firm capabilities on alliance formation. Strategic Management Journal, 20(5), 397–420. doi:10.1002/(SICI)1097-0266(199905)20:5<397::AID-SMJ35>3.0.CO;2-K

Gunasekaran, A. and Ngai, E. W. T. (2004). Information systems in supply chain integration and management. European Journal of Operational Research, 159(2), 269–295.

Herva, M., Franco, A., Carrasco, E. F. and Roca, E. (2011). Review of corporate environmental indicators. Journal of Cleaner Production, 19(15), 1687–1699.

Hult, T., Ketchen, D. and Arrfelt, M. (2007). Strategic supply chain management: improving Performance through a culture of competitiveness and knowledge development. Strategic Management Journal, 28, 1035–1052.

Jean, R.-J. “Bryan”, Sinkovics, R. R. and Kim, D. (2008). Information technology and organizational performance within international business to business relationships: A review and an integrated conceptual framework. International Marketing Review, 25(5), 563–583.

Jenkin, T. A., Webster, J. and McShane, L. (2011). An agenda for [`]Green’ information technology and systems research. Information and Organization, 21(1), 17-40. doi:10.1016/j.infoandorg.2010.09.003

Jenkins, H. and Yakovleva, N. (2006). Corporate social responsibility in the mining industry: Exploring trends in social and environmental disclosure. Journal of Cleaner Production, 14(3), 271–284.

Kim, D., Cavusgil, S. T. and Calantone, R. J. (2006). Information System Innovations and Supply Chain Management: Channel Relationships and Firm Performance. Journal of the Academy of Marketing Science, 34(1), 40–54. doi:10.1177/0092070305281619

Kolk, A. (2008). Sustainability, accountability and corporate governance: exploring multinationals’ reporting practices. Business Strategy and the Environment, 17(1), 1–15.

Kotabe, M., Martin, X. and Domoto, H. (2003). Gaining from Vertical Partnerships: Knowledge Transfer, Relationship Duration and Supplier Performance Improvement in the U.s. and Japanese Automotive Industries. Strategic Management Journal, 24(4), 293..

Lamming, R. C. and Hampson, J. (1996). The Environment as a Supply Chain Management Issue, British Journal of Management, 7 (March Special Issue), 45–62.

Lee, H. L. (2000). Creating value through supply chain integration. Supply Chain Management Review.

Lee, H. L., So, K. C. and Tang, C. S. (2000). The value of information sharing in a two-level supply chain. Management science, 46(5), 626–643.

Leire, C. and Thidell, Å. (2005). Product-related environmental information to guide consumer purchases – a review and analysis of research on perceptions, understanding and use among Nordic consumers. Journal of Cleaner Production, 13(10–11), 1061–1070. doi:10.1016/j.jclepro.2004.12.004

Lewis, I. A. and Talalayevsky, A. (1997). Logistics and Information Technology: A Coordination Perspective. Journal of Business Logistics. Retrieved from http://trid.trb.org/view.aspx?id=564483

Li, S. and Lin, B. (2006). Accessing information sharing and information quality in supply chain management. Decision Support Systems, 42(3), 1641–1656.

Liu, X. and Anbumozhi, V. (2009). Determinant factors of corporate environmental information disclosure: an empirical study of Chinese listed companies. Journal of Cleaner Production, 17(6), 593–600. doi:10.1016/j.jclepro.2008.10.001

Mann, H., Kumar, U., Kumar, V. and Mann, I. J. S. (2010). Drivers of Sustainable Supply Chain Management. IUP Journal of Operations Management, 9(4), 52-63.

Melnyk, S. A., Sroufe, R. P. and Calantone, R. (2003). Assessing the impact of environmental management systems on corporate and environmental performance. Journal of Operations Management, 21(3), 329–351.

Moberg, C. R., Cutler, B. D., Gross, A. and Speh, T. W. (2002). Identifying antecedents of information exchange within supply chains. International Journal of Physical Distribution and Logistics Management, 32(9), 755–770. doi:10.1108/09600030210452431
Mogensen, B. and Holbech, A. (2007). Analysis of legal requirements for reporting of environmental information in annual reports in the Nordic countries. PricewaterhouseCoopers
Morrow, D. and Rondinelli, D. (2002). Adopting Corporate Environmental Management Systems:: Motivations and Results of ISO 14001 and EMAS Certification. European Management Journal, 20(2), 159–171.
Nakano, K. and Hirao, M. (2011). Collaborative activity with business partners for improvement of product environmental performance using LCA. Journal of Cleaner Production, 19(11), 1189–1197. doi:10.1016/j.jclepro.2011.03.007
NOCI, G. (1997). Designing 'Green' Vendor Rating Systems for the Assessment of a Supplier's Environmental Performance, European Journal of Purchasing and Supply Management, 3(2), 103–114
Nunnally, J. C. (1978). Psychometric theory (2nd ed.). New York: McGraw-Hill.
Patnayakuni, R., Rai, A. and Seth, N. (2006). Relational Antecedents of Information Flow Integration for Supply Chain Coordination. Journal of Management Information Systems, 23(1), 13–49.
Preuss, L. (2005). Rhetoric and reality of corporate greening: a view from the supply chain management function. Business Strategy and The Environment 14, 123–139.
Raghunathan, S. (2001). Information Sharing in a Supply Chain: A Note on its Value when Demand Is Nonstationary. Management Science, 47(4), 605–610.
Rai, A. and Tang, X. (2010). Leveraging IT Capabilities and Competitive Process Capabilities for the Management of Interorganizational Relationship Portfolios. Information Systems Research, 21(3), 516 -542. doi:10.1287/isre.1100.0299
Rai, A., Bush, A. and Tiwana, A. (2005).Adaptive Planning and Optimization for Supply Chain Networks, White Paper. University Thought Leadership Forum on Adaptive Supply Chain Networks, SAP.
Rai, A., Patnayakuni, R. and Patnayakuni, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. MIS Quartertly, 30(2), 225–246.
Rai. A., Ruppel. C. and Lewis, M. (2002). Sense and Respotid, White Paper, University Thought Leadership Forum, SAP.
Rao, P. (2002). Greening the supply chain: a new initiative in South East Asia , International Journal of Operations and Production Management, 22( 6), 632-55
Rex, E. and Baumann, H. (2007). Beyond ecolabels: what green marketing can learn from conventional marketing. Journal of cleaner production, 15(6), 567–576.
Riggins, F. J., Kriebel, C. H. and Mukhopadhyay, T. (1994). The Growth of Interorganizational Systems in the Presence of Network Externalities. Management Science, 40(8), 984–998
Ringle C. M., Wende, S. and Will, A. (2005). SmartPLS 3edn, University of Hamburg, Hamburg, Germany.
Saraf, N., Langdon, C. S. and Gosain, S. (2007). IS Application Capabilities and Relational Value in Interfirm Partnerships. Information Systems Research, 18(3), 320–339. doi:10.1287/isre.1070.0133
Sarkis, J. (2012). A boundaries and flows perspective of green supply chain management. Supply Chain Management: An International Journal, 17(2), 7–7.
Sarkis, J., Zhu, Q. and Lai, K. (2011). An organizational theoretic review of green supply chain management literature. International Journal of Production Economics, 130(1), 1–15. doi:10.1016/j.ijpe.2010.11.010
Schneidrjans, M. J. (1993). Topics in just-in-time management.Needham Heights, MA: Allyn and Bacon.
Seidmann, A. and Sundararajan, A. (1997). Building and sustaining interorganizational information sharing relationships: the competitive impact of interfacing supply chain operations with marketing strategy. Proceedings of the eighteenth international conference on Information systems, ICIS '97

(pp. 205–222). Atlanta, GA, USA: Association for Information Systems. Retrieved from http://dl.acm.org/citation.cfm?id=353071.353121
Sharma, S. (2000). Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy. Academy of Management Journal, 43, 681-697.
Srivastava, S. (2007). Green supply-chain management: a state-of-the-art literature review. International Journal of Management Reviews, 9(1), 53–80.
Shrivastava, P. (1995). The Role of Corporations in Achieving Ecological Sustainability. Academy of Management Review, 20(4), 936–960. doi:10.5465/AMR.1995.9512280026
Smith, B. J. and Barclay, D. W. (1997). The effects of organizational differences and trust on the effectiveness of selling partner relationships. Journal of Marketing, 61(1), 3-21.
Solér, C., Bergström, K. and Shanahan, H. (2010). Green supply chains and the missing link between environmental information and practice. Business Strategy and the Environment, 19(1), 14–25. doi:10.1002/bse.655
Stank, T., Crum, M. and Arango, M. (1999). Benefits of interfirm coordination in food industry supply chains. Journal of Business Logistics. 20(2), 21-41
Steger, U. (2000). Environmental management systems: empirical evidence and further perspectives. European Management Journal, 18(1), 23–37.
Teixeira, A. A., Chiappetta Jabbour, C. J., Caldeira Oliveira, J. H., Gomes Battistelle, R. A. and Castro, R. de (2011). Environmental practices and motivational elements: A study of leading Brazilian companies. Environmental Quality Management, 21(1), 39-51. doi:10.1002/tqem.20307
Thun, J. and Muller, A. (2008). An empirical analysis of green supply chain management in the German automotive industry, Business Strategy and the Environment. 19(2), 119-132.
Thøgersen, J., Haugaard, P. and Olesen, A. (2010). Consumer responses to ecolabels. European Journal of Marketing, 44(11/12), 1787–1810.
Vachon, S. and Klassen, R. D. (2006a). Extending green practices across the supply chain: The impact of upstream and downstream integration. International Journal of Operations & Production Management, 26(7), 795–821. doi:10.1108/01443570610672248
Vachon, S. and Klassen, R. D. (2006b). Green project partnership in the supply chain: the case of the package printing industry. Journal of Cleaner Production, 14(6), 661–671.
van den Hoven, J. (2004). Data architecture standards for the effective enterprise. Information systems management, 21(3), 61–64.
Wassmer, U. (2010). Alliance portfolios: A review and research agenda. Journal ofManagement, 36, 141-171.
Wassmer, U. and Dussauge, P. (2011). Value creation in alliance portfolios: The benefits and costs of network resource interdependencies. European Management Review, 8, 47-64.
Wassmer, U. and Dussauge, P. (2012). Network resource stocks and flows: how do alliance portfolios affect the value of new alliance formations? Strategic Management Journal, 33(7), 871–883. doi:10.1002/smj.973
Wassmer, U., Paquin, R. and Sharma, S. (2012). The Engagement of Firms in Environmental Collaborations: Existing Contributions and Future Directions. Business and Society. doi:10.1177/0007650312439865
Watson, R. T., Boudreau, M.-C., Chen, A. and Huber, M. H. (2008). Green IS: Building Sustainable Business Practices, in Information Systems, R. T. Watson (ed.), Athens, GA: Global Text Project.
White, C.J., Varadarajan, R.P. and Dacin, P.A. (2003). Market situation interpretation and response: The role of cognitive style, organizational culture, and information use. Journal of Marketing, 67(3), 63-79.
Wu, F., Yeniyurt, S., Kim, D. and Cavusgil, S. T. (2006). The impact of information technology on supply chain capabilities and firm performance: A resource-based view. Industrial Marketing Management, 35(4), 493–504.
Yu, Z., Yan, H. and Cheng, T. C. E. (2001). Benefits of information sharing with supply chain partnerships. Industrial management & Data systems, 101(3), 114–121.

Zhu, Q. and Sarkis, J. (2006). An inter-sectoral comparison of green supply chain management in China: drivers and practices , Journal of Cleaner Production, 14, 472-86

# Appendix

| | | |
|---|---|---|
| Product-related environmental information availability | Using environmentally extended input-output (EEIO) models | 0.95 |
| Product-related environmental information availability | Executing life cycle assessment studies on own products | 0.94 |
| Sharing of product-related environmental information | Receiving information about the carbon emissions/energy consumption of raw materials or products from suppliers | 0.94 |
| Sharing environmental information | Providing information about the carbon emissions//energy consumption of produced products to supply chain partners | 0.95 |
| Environmental Collaboration | Achieving environmental goals collectively | 0.96 |
| Environmental Collaboration | Developing a mutual understanding of responsibilities regarding environmental performance | 0.96 |
| Environmental Collaboration | Working together to reduce environmental impact of our activities | 0.96 |
| Environmental Collaboration | Making joint decisions about ways to reduce overall environmental impact of our product | 0.94 |
| Environmental Corporate Strategy | At our firm. we make every effort to link environmental objectives with other corporate goals | 0.92 |
| Environmental Corporate Strategy | Our firm is engaged in developing products and processes that minimize environmental impact | 0.93 |
| SC Collaboration | Our firm provides information to help our primary partners (primary suppliers or major customers respectively) to improve | 0.89 |
| SC Collaboration | Our firm exchanges operational and logistical information with primary partners | 0.89 |
| SC Collaboration | Our firm informs our primary partners about events or changes that may affect them | 0.89 |
| SC Collaboration | Our firm has face-to-face communication with primary partners for planning purpose | 0.90 |
| Data Consistency | Definitions of key data elements (e.g., customer, order, part number) are common across our firm's supply chain | 1.00 |
| Cross-Functional Application Integration | Supply chain transaction applications (e.g.. order management, procurement, manufacturing and distribution) communicate in real time | 0.94 |
| Cross-Functional Application Integration | Supply chain applications with internal applications of our organization (such as enterprise resource planning) communicate in real time | 0.93 |
| Physical Flow Integration | Supply chain-wide inventory is jointly managed with suppliers and logistics partners | 1.00 |
| Information Flow Integration | Performance metrics are shared across our firm's supply chain | 0.90 |
| Information Flow Integration | We share actual sales data with our major supply chain partners (e.g.. distributors, wholesalers, retailers) | 0.87 |

*Table 2. Constructs, items, and loadings*

| | Cronbachs Alpha | Composite Reliability | AVE | 1[1] | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cross-Functional Application Integration | 0.86 | 0.93 | 0.87 | 0.93 | | | | | | | | |
| Data Consistency | 1.00 | 1.00 | 1.00 | 0.69 | 1.00 | | | | | | | |
| Product-related environmental information availability | 0.88 | 0.95 | 0.90 | 0.15 | -0.01 | 0.95 | | | | | | |
| Environmental Collaboration | 0.97 | 0.98 | 0.91 | 0.23 | 0.19 | 0.36 | 0.95 | | | | | |
| Environmental Corporate Strategy | 0.82 | 0.92 | 0.85 | 0.40 | 0.16 | 0.45 | 0.41 | 0.92 | | | | |
| Information Flow Integration | 0.72 | 0.88 | 0.78 | 0.64 | 0.53 | 0.27 | 0.35 | 0.35 | 0.88 | | | |
| Physical Flow Integration | 1.00 | 1.00 | 1.00 | 0.68 | 0.50 | 0.07 | 0.06 | 0.24 | 0.59 | 1.00 | | |
| SC Collaboration | 0.92 | 0.94 | 0.80 | 0.56 | 0.39 | 0.19 | 0.40 | 0.24 | 0.48 | 0.42 | 0.90 | |
| Sharing of product-related environmental information | 0.88 | 0.94 | 0.89 | 0.19 | 0.02 | 0.65 | 0.49 | 0.41 | 0.33 | 0.19 | 0.33 | 0.94 |

*Table 3.Reliability, correlation matrix, and average variance extract*

*Note: The diagonal elements represent the square root of AVE and the off-diagonal the correlations.*

| | 1[2] | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Product-related environmental information availability_1 | **0.95** | 0.64 | 0.38 | 0.40 | 0.23 | 0.04 | 0.17 | 0.10 | 0.25 |
| Product-related environmental information availability_2 | **0.94** | 0.59 | 0.31 | 0.45 | 0.13 | -0.06 | 0.12 | 0.04 | 0.25 |
| Sharing of product-related | 0.64 | **0.94** | 0.42 | 0.41 | 0.38 | 0.00 | 0.23 | 0.17 | 0.29 |

[1] 1 = Cross-Functional Application Integration, 2 = Data Consistency, 3 = Product-related environmental information availability, 4 = Environmental Collaboration, 5 = Environmental Corporate Strategy, 6 = Information Flow Integration, 7 = Physical Flow Integration, 8 = SC Collaboration, 9 = Sharing of product-related environmental information

[2] 1 = Product-related environmental information availability, 2 = Sharing of product-related environmental information, 3 = Environmental Collaboration, 4 = Environmental Corporate Strategy, 5= SC Collaboration, 6 = Data Consistency, 7 = Cross-Functional Application Integration, 8 = Physical Flow Integration, 9 = Information Flow Integration

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| environmental information_1 | | | | | | | | | |
| Sharing of product-related environmental information_2 | 0.58 | **0.95** | 0.51 | 0.38 | 0.24 | 0.03 | 0.14 | 0.19 | 0.34 |
| Environmental Collaboration_1 | 0.31 | 0.45 | **0.96** | 0.36 | 0.37 | 0.13 | 0.16 | -0.02 | 0.27 |
| Environmental Collaboration_2 | 0.35 | 0.49 | **0.96** | 0,36 | 0.36 | 0.22 | 0.24 | 0.08 | 0.38 |
| Environmental Collaboration_3 | 0.38 | 0.51 | **0.96** | 0.45 | 0.39 | 0.22 | 0.25 | 0.11 | 0.37 |
| Environmental Collaboration_4 | 0.34 | 0.42 | **0.94** | 0.40 | 0.39 | 0.16 | 0.24 | 0.06 | 0.29 |
| Environmental Corporate Strategy_1 | 0.39 | 0.33 | 0.37 | **0.92** | 0.30 | 0.19 | 0.48 | 0.23 | 0.32 |
| Environmental Corporate Strategy_2 | 0.43 | 0.43 | 0.39 | **0.93** | 0.16 | 0.11 | 0.26 | 0.21 | 0.32 |
| SC Collaboration_1 | 0.17 | 0.34 | 0.40 | 0.31 | **0.89** | 0.25 | 0.46 | 0.30 | 0.36 |
| SC Collaboration_2 | 0.17 | 0.35 | 0.41 | 0.19 | **0.89** | 0.43 | 0.51 | 0.49 | 0.54 |
| SC Collaboration_3 | 0.19 | 0.23 | 0.30 | 0.23 | **0.89** | 0.43 | 0.59 | 0.42 | 0.47 |
| SC Collaboration_4 | 0.13 | 0.20 | 0.24 | 0.11 | **0.90** | 0.25 | 0.43 | 0.25 | 0.33 |
| Data Consistency | -0.01 | 0.02 | 0.19 | 0.16 | 0.39 | **1.00** | 0.69 | 0.50 | 0.53 |
| Cross-Functional Application Integration_1 | 0.12 | 0.22 | 0.26 | 0.40 | 0.50 | 0.69 | **0.94** | 0.73 | 0.70 |
| Cross-Functional Application Integration_2 | 0.17 | 0.14 | 0.18 | 0.34 | 0.55 | 0.60 | **0.93** | 0.54 | 0.50 |
| Physical Flow Integration | 0.07 | 0.19 | 0.06 | 0.24 | 0.42 | 0.50 | 0.68 | **1.00** | 0.59 |
| Information Flow Integration_1 | 0.28 | 0.34 | 0.35 | 0.31 | 0.52 | 0.55 | 0.72 | 0.60 | **0.90** |
| Information Flow Integration_2 | 0.19 | 0.24 | 0.26 | 0.29 | 0.32 | 0.38 | 0.40 | 0.43 | **0.87** |

*Table 4. Cross-loadings of items on various constructs*