Abstract

This article identifies empirically the effects of environmental collaboration in the supply chain on operational and financial performance of manufacturing firms. Self-reported survey data is combined with financial reporting data on 135 manufacturing firms operating in Finland. Environmental collaboration within the firm and externally with customers and suppliers is studied against measures of firm performance by applying descriptive analysis, confirmatory factor analysis and generalised linear modelling. The novelty in this research is the combination of self-reported survey data with financial reports-based data in analysing the effects of three dimensions of environmental collaboration on firm performance. The findings suggest that while external collaboration had mostly positive effects, internal collaboration seems to be more problematic. The results highlight the need for supply chain focus in environmental issues. Manufacturing firms should not consider environmental efforts merely as an extra burden: there seem to be ways of putting in more effort without jeopardising performance.

Keywords: environmental collaboration, firm performance, financial performance, manufacturing

Research paper

1. Introduction

Environmental sustainability has attracted growing interest in the political discussion over the last few decades. The Brundtland Report for the UN, published under the title of 'Our Common Future' in 1987 (United Nations, 1987) claims that there are sustainability-related limits on economic growth. Such limits are of great relevance to firms seeking profitable growth within the constraints of scarce resources. Sustainability is often conceptualised using the triple bottom line (Elkington, 1997), suggesting that firms need to engage in environmentally and socially responsible behaviour, which can result in positive economic gains in the process (Gimenez et al., 2012).

This research examines the economic and environmental dimensions of sustainability, particularly in the context of green supply chain management (GSCM).

Supply chain activities, especially transportation, are acknowledged as a major source of environmental impact (Wu et al., 1995). Using resources for economic activities causes environmental issues that are not borne by the users and hence they cannot be managed within organisational boundaries (Linton et al., 2007). Integrating the supply chain might produce environmental benefits (Beamon 1999a). GSCM integrates environmental thinking into supply chain management, including product design, material sourcing, manufacturing processes, customer deliveries, and end-of-life management (Srivastava, 2007), which provides an excellent foundation for improving sustainability (Linton et al., 2007). Because of this, GSCM is attracting more and more attention in business and academia.

The adoption of GSCM practices in organisations can be encouraged by external factors, which are mostly linked to stakeholder pressure for environmentally sustainable products and processes, and internal factors stemming from business-led strategic processes (e.g. Walker et al., 2008; Testa & Iraldo, 2010; Green et al., 2012; Zhu et al., 2013; Chavez et al., 2014).

The traditional view is that firms engage in environmental activities due to external pressure from stakeholders, such as customers, employees, shareholders, governments and non-governmental organisations (NGOs) (Kim & Lee, 2012). Due to pressure from stakeholders, for example, managers are challenged to determine how to incorporate environmental-management principles into their daily decision-making (Wu and Dunn, 1995). However, there are barriers, such as costs, lack of legitimacy and poor supplier commitment that are frequently mentioned to inhibit more proactive stance towards environmental issues (Walker et al., 2008).

Recently many authors have challenged this traditional view that firms are forced into environmental action, claiming that in fact "being green" pays off. Walker et al. (2008) mention several internal drivers, such as desire to reduce costs, improve quality, values of the owner and employee involvement that have been found to be positively related to the implementation of green initiatives. Building on the resource based view Shi et al. (2012) argue that organisations implementing internal environmental practices create causally ambiguous resources while external environmental practices create socially complex resources that can be translated into improved environmental and operational performance and further lead to improvements in financial performance. Moreover, the positive effects on image and reputation can be considered a significant resource (Sarkis et al., 2011). Prior research suggests that GSCM adoption improves environmental performance (e.g. Rao & Holt, 2005; De Giovanni & Esposito Vinzi, 2012; Zhu et al., 2013), quality, delivery, flexibility and cost performance (Vachon & Klassen 2008; Chavez et al., 2014), and financial performance (King & Lenox, 2001; Rao & Holt, 2005; De Giovanni & Esposito Vinzi, 2012; Yang et al., 2013; Zhu et al., 2013). Nevertheless, it is still unclear how the specific types of GSCM practices translate into strategic resources which might eventually bring about performance improvement and competitive advantage (Shi et al., 2012).

There is a lack of empirical research that examines GSCM from a holistic and integrated supply chain perspective, including both upstream and downstream sides as well as the internal processes (Green et al. 2012; Yu et al., 2014). The focus of this article is on a specific type of GSCM, i.e. environmental collaboration. Collaboration is necessity for firms wishing to minimise their environmental impacts, since their ability to do so is to a large extent dependent on their relationships with external supply chain partners (Darnall et al., 2008). In order to get a better understanding of the phenomenon, the current research addresses collaborative actions within the firm, and with customers and suppliers, especially on environmental questions.

Even though GSCM has attracted its fair share of attention during the past few years, its benefits have not been widely tested on empirical level, which could be used as a foundation for theory building and theory testing (Green et al. 2012). Given the inconclusiveness of the existing body of research, it remains unclear if firms with higher level of GSCM perform better (Rao & Holt 2005; Green et al. 2012; Lai & Wong 2012; Zhu et al. 2013).The lack of clear relationship between GSCM practices and performance improvements is an obstacle for manufacturers seeking to justify GSCM implementation (Zhu et al., 2012).

The aim in this article is to present evidence about the effects of environmental collaboration on the intra-firm supply chain performance and financial performance of manufacturing firms. Previous literature refers to performance from the supply-chain perspective, but the analyses focus mainly on the impact of environmental activities on performance on the plant level. Much of the previous literature within GSCM has utilized self-reported measures from a single source (Wang & Sarkis, 2013; Seuring & Muller, 2008). Although there are some studies that have combined data from multiple sources (e.g. Markley & Davis, 2007; Wang and Sarkis, 2013), the samples have a tendency to be biased towards environmentally proactive companies. Furthermore, Hervani et al. (2005) call for future research on GSCM beyond single dyadic relationship. The novelty in this research is that it combines self-reported survey data with data from financial reports, and further contributes in analysing the effects of internal and external environmental collaboration with suppliers and customers on intra-firm supply chain performance and financial performance.

There are five sections in this article. The introduction is followed by a review of previous literature, on the basis of which the research hypotheses are postulated. Section three describes the research design, including sampling techniques, measures and data analysis. Section four presents the results of the empirical analysis. Finally, the theoretical and managerial implications of the findings are discussed in section five.

2. Research concepts and hypotheses

2.1. Environmental collaboration

Manufacturers have increasingly adopted a supply chain-wide management approach for environmental management in the form of green supply chain management (GSCM) (Zhu et al., 2013). Rao and Holt (2005) define GSCM as promoting efficiency and synergy among business partners, and helping to improve environmental performance, minimise waste, and achieve cost savings. Within this context, one should distinguish between GSCM and the closely related concept of sustainable supply chain management (SSCM), which Carter and Rogers (2008) define as: "the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual firm and its supply chains". While the integration of environmental thinking into supply chain management (SCM) practices is focal in almost all of the definitions of GSCM, the definitions of SSCM adopt a broader triple bottom line perspective (Ahi & Searcy 2013). Together they will be components of the broader SSCM concept (Wang & Sarkis, 2013). The GSCM practices can be implemented at a strategic, tactical or operational level and they can be related to the supply process, the product itself, the delivery process or advanced actions involving some kind of innovation (Azevedo et al., 2011).

The approach of this article is environmental management from the perspective of environmental collaboration, which Vachon and Klassen (2008) define as "the direct involvement of an organization with its suppliers and customers in planning jointly for environmental management and environmental solutions". Environmental collaboration includes a mutual willingness to learn about each other's operations and exchanging technical information (Vachon & Klassen, 2008), to access the expertise of partners in the supply chain and to gain synergies from the combined operations (Stank et al., 2001b).

Grekova et al. (2013) argue that environmental sustainability is an important theme for supply chain collaboration, and thus environmental collaboration is closely related to more general supply chain collaboration/integration, addressed by an ample number of studies (see e.g. Sanders and Premus, 2005; Wu et al., 2006; Fabbe-Costes et al., 2009; Flynn et al., 2010; Cao and Zhang, 2011).

However, Kuik et al. (2011) suggest that managing sustainable collaboration in manufacturing is in many ways more complex and requires more efforts than traditional supply chain collaboration, in areas ranging from forecast and demand activities to the stance towards environmental concerns.

The concepts of supply chain integration and supply chain collaboration have been used interchangeably in earlier literature (see e.g., Fabbe-Costes & Jahre, 2008; Lorentz, 2008; Leuschner et al., 2013). Integration means the unified control (or ownership) of several successive or similar processes formerly carried on independently (Webster's Third New International Dictionary, 1966; Flynn et al., 2010), the emphasis being on central control, ownership, or process integration governed by contract (Cao & Zhang, 2011). According to transaction cost analysis (TCA) theory, collaboration is the intermediate form of governance between vertical integration and market exchange (Nyaga et al., 2010). Hence, as Cao and Zhang (2011) suggest, collaboration seems to be a better construct to describe the cooperative relationship between autonomous partners in the supply chain.

Several authors have distinguished between two broad categories: internal collaboration (or intra-organisational coordination) and external collaboration (or inter-organisational coordination; see e.g., Stank et al., 2001a; Barratt, 2004). Flynn et al. (2010) argue that many extant studies have focused solely on customer and supplier side while ignoring the internal dimension. In this research, environmental collaboration in the supply chain is categorised first as internal or external, and external collaboration is further categorised as collaboration with customers or suppliers.

Whereas Vachon and Klassen concentrate on environmental collaboration in a manufacturing environment, this research extends the focus to a broader supply chain perspective. Following Yang et al. (2013) and Martinsen and Björklund (2010), internal environmental collaboration is defined in this research to involve green policy (e.g. well-defined environmental policy statement, commitment and support of staff for environmental projects, and cross-functional cooperation for environmental protection), green transport (e.g. fuels, vehicle technologies, modal choice, behavioural aspects, logistics systems design, transport management, supply chain partner selection, environmental management systems and emissions and energy data) and green marketing (e.g. providing customers with information on green services, larger budget on green advertising, using resource and energy conservation arguments in marketing, enticing customers with green initiatives and eco-services, and publishing environmental information in the company website) working together across different functions in environmental process improvement. External environmental collaboration is defined as working jointly with suppliers and customers to set and achieve environmental goals to reduce the environmental impact of the coordinated activities (Vachon & Klassen, 2006; Green et al., 2012).

Stank et al. (2001a) explored general supply chain collaboration and found that internal and external collaboration were strongly and positively connected. Similar results have been reported in the context of green supply chain management. According to Rao and Holt (2005), greening the firm's internal activities can lead to greening its external activities. De Giovanni and Esposito Vinzi (2012) and Zhu et al. (2013) found strong support for notion that internal environmental activities in the supply chain enhance the level of external environmental activities. De Giovanni and Esposito Vinzi (2012) suggest firms whose internal processes are environmentally sustainable can achieve sustainability along the whole supply chain, since internal environmental programmes provide competences and knowledge concerning how external environmental collaboration should work. Yang et al. (2013) postulate that internal green activities and integration enhance external green integration through organizational capabilities. A high level of internal communication and coordination increases the likelihood of a firm achieving a high level of external integration, evaluating new knowledge acquired from supply chain partners and understanding their business to facilitate external integration.

Hence, it is posited that:

Hypothesis 1. As internal environmental collaboration increases, external environmental collaboration also increases

2.2. Linkage between environmental collaboration and firm performance

2.2.1 *Environmental collaboration and financial performance*

Research on the linkage between environmental sustainability and firm performance have been increasing, yet the findings from these studies have been contradictory, giving practitioners no clear answers as to what actions would be beneficial to pursue (Golicic &Smith, 2013). In this research firm performance means intra-firm supply chain performance and financial performance. The concept intra-firm supply chain performance emphasizes how the properties of the inter-firm supply chain affect performance in the focal firm (measurement inside a firm) (Lorentz et al., 2012.)

Supply chain collaboration has traditionally been associated with performance gains, such as better customer service, lower inventory levels, more accurate forecasting (Kahn & Mentzer, 1996), responsiveness and flexibility (Stank et al., 1999, Flynn et al., 2010), and ultimately better financial performance and competitiveness in the market (Biehl et al., 2006; Chen et al., 2007, Flynn et al., 2010). Environmental collaboration is expected to bring about similar benefits. The resource-based view and its extension, the natural-resource-based view (NRBV) are widely used in explaining the relationship between environmental management and performance. The NRBV maintains that strategy and competitive advantage stem from capabilities facilitating environmentally sustainable economic activities (Hart, 1995). Hart (1995) argues that for a resource to be valuable, rare, inimitable and non-substitutable, it must possess three characteristics: it must be 1) causally ambiguous (or tacit), 2) socially complex and 3) firm-specific. On the other hand, another extension of the resource-based view, the relational view, posits that organisational capabilities can be developed by combining resources existing in different supply chain members (Dyer & Singh, 1998), hence creating causally ambiguous and socially complex resources that are difficult to duplicate by the competitors (Shi et al., 2012). Numerous researchers have studied the effects of environmental management, GSCM and environmental collaboration on firm performance. The results indicate negative or positive effects, or a mixture of both. One of the earliest studies is by Klassen and McLaughlin (1996) who argue that environmental management would have positive effects on environmental performance, and eventually on financial performance. Anderson et al. (2005) identified cost increases in employing sustainable policies in urban transport. Quak and de Koster (2007) also report cost increases in relation to retailers' sensitivity to local sustainability policies. Quariguasi Frota Neto et al. (2008) conclude that in the European paper and pulp industry, "The adoption of cleaner solutions is generally bounded by an increase in costs."

On the other hand, De Giovanni and Esposito Vinzi (2012) employed structured equation modelling in testing a set of hypotheses concerning the influence of internal and external environmental management on environmental and financial performance. They found that the effects of environmental management could be either positive or negative, depending on the model and measures of performance used and that internal environmental management has a larger impact than external activities on environmental and economic performance. Zhu and Sarkis (2004), in turn, identified a positive economic performance associated with GSCM, but stress that their results were based on the assumptions of the survey respondents, and that there was no supporting evidence from actual financial numbers. Aronsson and Huge-Brodin (2006) propose four types of change in relation to decision-making and the environment: standardisation, consolidation, a flexible understanding of warehousing and transportation, and visibility (new and better IS), which they claim lead to both positive environmental effects and lower costs. Zhu et al. (2008) also list enhanced economic performance as one of the potential advantages of GSCM.

King and Lenox (2001) studied 652 manufacturing firms over the time period of 1987-1996, and concluded that there was evidence of an association between lower pollution and higher financial valuation, using performance metrics such as Tobin's Q, Return on Assets (ROA), Return on Equity (ROE) and Return on Investment (ROI). They also acknowledge that the firms' characteristics and strategic position might be the cause, rather than active environmental management. Nakao et al. (2007) report similar results based on Japanese data, whereas Rao and Holt (2005) also identified a positive connection between GSCM and the firm's economic performance in a survey set-up.

There has been a growing need for firms to look beyond their organisational boundaries and to find partners to ensure that the supply chain is efficient and responsive to dynamic market needs (Cao & Zhang, 2011). Firms can form highly collaborative relationships with some supply chain members and arm's length relationships with others (Gimenez and Ventura, 2005). Environmental collaboration with external supply chain partners indicates that the firm is capable to effectively integrate internal and external expertise, skills and technology (Yang et al., 2013). Azevedo et al. (2011) emphasize that environmental collaboration with suppliers produces the same benefits as other non-green supply chain practices by increasing the level of supply chain integration, whereas environmental collaboration with customers increases the level of environmental awareness, reduces business waste and environmental costs, increases customer satisfaction and responsiveness while maximizing the return volumes. Hollos et al. (2012) found that while sustainable supplier co-operation did not have a significant direct effect on performance, green practices positively influence cost reduction.

A number of empirical studies (e.g. Rao & Holt, 2005; De Giovanni & Esposito Vinzi, 2012; Zhu et al., 2013) in the manufacturing sector have identified a positive connection between environmental practices in the supply chain and economic performance. Zhu et al. (2013), found that customer collaboration CC could either directly or indirectly through environmental and operational performance, bring economic benefits. The results of Yang et al. (2013) on performance outcomes of environmental activities among container shipping companies are in line with those conducted in the manufacturing context. The meta-analysis of over 20 years of research on environmental supply chain practices by Golicic and Smith (2013) found that accounting-based performance was less affected by GSCM practices that operational- or market-based performance. Yet the effect was not negative or nonsignificant.

Given these findings, the following hypothesis is posited:

Hypothesis 2. As environmental collaboration increases, the firm's financial performance improves

2.2.2 Environmental collaboration and intra-firm supply chain performance

Many concepts related to supply chain performance may or may not be included in the wide range of studies on the phenomenon. Constituents of supply chain performance mentioned in previous academic work include cost efficiency, for example (Beamon, 1999b; Schramm-Klein & Morschett, 2006). Chow et al. (1994) identify several measures of logistics performance, both hard and soft, such as financial and cost statistics and quality measures. Other authors also include operational variables such as service quality (Stank et al., 2001a; Gunasekaran et al., 2004). Morgan (2004) adds time-related factors to the list, whereas Whicker et al. (2009) measure performance as time, but end up with measures that overlap previous concepts by calculating costs and other monetary values. Fawcett and Cooper (1998) include a wide range of operational measures such as cash-to-cash cycle time with its various components, perfect order fulfilment, order-fulfilment cycle time and supply-chain response time. Morgan (2004) also includes financial performance, cost performance, customer service and productivity as different aspects of supply chain performance. In this research however, financial performance and intra-firm supply chain performance are considered separate. Following the example of Lorentz et al. (2012) intra-firm supply chain performance is considered to consist of operational measures and further divided into the following three dimensions: logistics costs, customer-service performance and asset utilisation, whereas financial performance is considered to consist of accounting based measures.

Empirical research on the effect of environmental collaboration on intra-firm supply chain performance is still scarce. According to the results reported by González-Benito and González-Benito (2005), implementing environmental practices related to internal production processes has a negative effect: these practices, which are control-oriented rather than preventive, may not be optimal in terms of costs or time. However, they also found that environmental practices related to the transformation of logistics processes contributed positively to lean operational performance in terms of quality, reliability and volume flexibility.

Vachon and Klassen (2008) concentrated on the effects of environmental collaboration on manufacturing performance, finding that the benefits of collaboration with suppliers were the broadest, whereas in the case of customers the results were mixed. Zhu et al. (2013) used path analysis to examine the relationship between internal and external GCSM practices and performance. One of the dimensions they addressed was operational performance, measured in terms of an increase in the number of goods delivered on time and in the product line, a decrease in inventory levels and in the scrap rate, and improved product quality and capacity utilisation: they found a positive link from operational performance and internal environmental practices to external environmental collaboration with customers.

Zhu et al. (2008) constructed a model measuring the implementation of GSCM practices, which includes internal environmental management, green purchasing, cooperation with customers, eco-design and investment recovery. They also list a set of performance outcome measures that include not only emissions and waste, but also decrease in costs and environmental fees, operational performance, increases in perfect order fulfilment and timeliness, and decreased inventory levels. The meta-analysis by Golicic and Smith (2013) revealed that nearly any environmental supply chain practice influenced operational efficiency and effectiveness.

Porter and van der Linde list benefits associated with environmental process improvement, such as reduction of material and storage handling costs, reduction of the cost of activities involved in waste handling and transportation. Transport costs constitute the largest logistics cost item (Engblom et al., 2012), and given that environmentally responsible logistics system usually favors fewer shipments, more direct shipping routes and better space utilization (Wu & Dunn, 1995), environmental collaboration within the firm and with key supply chain partners is expected to reduce logistics costs.

Hence, it is proposed that:

Hypothesis 3. As environmental collaboration increases, the firm's logistics cost performance improves

Vachon and Klassen (2008) found that environmental collaboration with suppliers was linked with speed and delivery reliability. Azevedo et al. (2011) argue that environmental collaboration with suppliers produces the same benefits as non-green supplier collaboration due to increased level of integration. However, Hollos et al. (2012) point out that sustainable supplier co-operation leads to superior performance if the buying firm not only collaborates with the supplier on environmentally friendly practices, but combines the supplier’s efforts with its internal efforts.

Improvements in the ability to coordinate operations across different supply chain members to respond to changes in customer requirements increase customer satisfaction (Gunasekaran et al., 2008). On the other hand, environmental collaboration with major customers was found to affect product quality positively in terms of conformance to specifications and durability. (Vachon & Klassen, 2008). For example, working with customers in eco-design contributes to customer satisfaction as it reduces the rejection rate (Azevedo et al., 2011).

Hence, it is posited that:

Hypothesis 4. As environmental collaboration increases, the firm's service performance improves

GSCM is often associated with quality improvements and efficiency (e.g. Porter & van der Linde, 1995; Rao & Holt, 2005; Vachon & Klassen 2008). Porter and van der Linde (1995) suggest that environmental improvements reduce downtime due to more careful monitoring and maintenance. Eliminating non-value adding time in the supply chain the firm will be able to lower its needs for working capital (Christopher and Ryals, 1999). Traditional supply chain collaboration is likely to improve asset utilisation (Zacharia et al., 2009). For example, better information sharing can improve asset utilisation, cash flow and cycle times (Patnayakuni et al., 2006). The same principle can be expected to apply to environmental collaboration.

Thus, it is posited:

Hypothesis 5. As environmental collaboration increases, the firm's asset utilisation improves

Figure 1 below illustrates the above hypotheses derived from the literature.

INSERT FIGURE 1 HERE

3. Research design

3.1. Construct measurement

Previously, Vachon and Klassen (2008) have measured environmental collaboration in the supply chain with two composite measures each consisting of five individual items. The original measures of Vachon and Klassen (2008) included identical dimensions of environmental goals, mutual understanding of responsibilities, and planning and co-operation in environmental questions, with one of the composite measures concentrating on environmental collaboration with key suppliers and the other focused on collaboration with customers.

Adding to these two measures, a third set of questions was constructed for this research by replicating the dimensions of composite measures by Vachon and Klassen (2008) to measure the extent of collaboration in these dimensions within the firm.

The composite measures and the individual items are presented in Table 1. These items were further subjected to confirmatory factor analysis with the a priori assumption that the items measuring environmental collaboration with suppliers, customers and within the firm would load on their corresponding factors, creating composite measures as assumed. Based on the results of confirmatory factor analysis (Appendix 1) three composite measures (INTER, SUPPL, CUST) were formed by summing up the scores individual items. Here, firm performance means intra-firm supply chain performance comprising the following dimensions: logistics costs, customer-service performance and asset utilisation, and financial performance. Customer-service performance is defined as perfect order fulfilment and order-fulfilment cycle time. Asset utilisation includes the elements of cash-to-cash cycle time and inventory days of supply, as defined by Lorentz et al. (2012).

The survey respondents were asked to provide information on a set of various key figures: 1) the perfect-order-fulfilment rate, 2) the order-delivery time in days for the perfect-order-fulfilment rate, 3) the average payment time among the customers in days (days of sales outstanding), 4) the time in days that materials were in the possession of the firm (inventory days of supply), 5) the supplier's delivery accuracy, 6) the average payment time in the firm in days (days of payables outstanding), and 7) the average payment time among the suppliers in days (days of sales outstanding). The cash-to-cash cycle time was calculated based on measures 3), 4) and 6).

Logistics costs were divided into five components as classified by Engblom et al. (2012) 1) transportation and packing costs, 2) warehousing costs, 3) inventory carrying costs, 4) logistics administration costs and 5) other logistics costs. These were measured as self-reported, open-field responses as a percentage of the firm's turnover. According to Stewart (1995), this provides a robust basis for analysis. The estimate for the total logistics cost comprised the sum of the individual components.

Financial performance was measured in terms of Return on Assets (Watson et al., 2004), Return on Capital Employed and the EBIT percentage (Wagner, 2005), combining the data from the financial reports with the survey data. The financial-performance metrics used in the analysis comprised (1) the return on total assets (ROA) in the year 2011, (2) the return on capital employed (ROCE) in the year 2011, and (3) the earnings before interest and taxes percentage (EBIT%) in the year 2011. The EBIT percentage was included in order to check whether profitability behaved differently compared to asset-based measures. The research variables are summarised in Table 1.

INSERT TABLE 1 HERE

Four dummy variables were used to control for the following characteristics: firm size was measured as turnover and divided between small and medium-sized firms and large firms; manufacturing strategy as firms employing mainly push and pull strategies; industry orientation, based on whether or not the firm belonged to the Finnish "technology industries" interest group (manufacturers of electronics, machinery and basic metals), and value added based on whether the average value-added percentage was above or below that of Finnish manufacturing.

3.2. Dataset

The analysed dataset comprised of (1) survey data collected in Finland and (2) financial-reporting-based data from the Orbis database.

Finland could be considered an interesting source of survey data for various reasons. First, as evaluated by international freight forwarders and other logistics professionals, Finland was ranked third among 155 countries in the World Bank's Logistics Performance Index (Arvis et al., 2012). Second, Finland is a highly industrialised open economy, with the 15^{th} highest GDP per capita (approximately USD 49,400 in 2011) in the world (World Bank, 2012). Third, Finland was ranked third after Switzerland and Singapore in the World Economic Forum's Global Competitiveness Index 2012-2013 (World Economic Forum, 2013).

The survey data was collected as part of the Finland State of Logistics 2012 survey (Solakivi et al., 2012) during January-February 2012, by means of a web-based questionnaire. The sample frame was all non-student members of the Finnish Association of Purchasing and Logistics (LOGY), members of the Finnish Transport and Logistics association (SKAL), and members of the Federation of Finnish Enterprises, active in the industries covered in the survey. In total, 2,732 responses from manufacturing, trading and logistics firms were received, the overall response rate being seven per cent. The majority (78%) of the respondents identified themselves as in the top management of the firm, whereas eight per cent were among middle management and four per cent were logistics experts. The remaining 10 per cent of respondents represented other tasks in the supply chain.

This particular research, however, focuses on manufacturing firms that provided complete responses for the research variable, and for which financial-reporting-based data was available from the Orbis database. Micro-sized firms were omitted from the analysis on the basis of the turnover criterion in the European Commission's definition; i.e., firms with a turnover of less than two million euros. In total the analysed sample consisted of 135 firms.

The sample comprises 33 large firms (25%), 32 medium-sized firms (23%) and 70 small firms (52%). Of all manufacturing firms in Finland, 0.2 per cent is considered to be large, whereas the share of medium-sized firms is 0.9 per cent and that of small firms is 5.5 per cent (Statistics Finland, 2010). As a result, the sample used in this article is biased towards larger firms if compared to the entire population of Finnish firms.

3.3. The distributions of the dependent variables and used research methods

One of the key assumptions of linear regression analysis is the multivariate normality of the analysed variables. Neglecting this assumption may lead to biased results (Gujarati and Porter, 2009). With this in mind, the normality of the distributions of the dependent and independent variables were assessed. Some of the dependent variables turned out to be positively skewed in such an order of magnitude that regular regression analysis was considered unsuitable. This applied to the individual components of logistics costs (Transportation, Warehousing, Inventory carrying, Logistics administration and Other costs) and the total logistics costs (the sum of these five components) as a percentage of the firm's turnover. As the measures of logistics costs were defined to be non-normally distributed, the ordinary regression analysis was abandoned and generalised linear models were used for the analysis.

Generalized linear models are a generalisation of ordinary regression that also allows distributions other than normal distribution. These models are all linear models, where

$$\boldsymbol{Y} = \boldsymbol{\mu} + \boldsymbol{\varepsilon}. \tag{1}$$

Linear dependency between the dependent and independent variables is assumed through a link function (η) where

$$\eta(\boldsymbol{\mu}) = \boldsymbol{X\beta} \tag{2}$$

and X stands for the independent variables and the β slope estimates of the model. The starting model is (in scalar form):

$$\eta = \alpha_1 + \beta_1 INTER_1 + \beta_2 SUPPL_2 + \beta_3 CUST_3 + SIZE_4 + MANSTRAT_5 + TECH_6 + VALUE_7 \tag{3}$$

, where η represents the link function used in the analysis and is model-dependent.

Dodd et al. (2006) have argued that Gamma distribution is the most suitable for cost analysis, whereas Engblom et al. (2012) used Beta distribution. Following the examples of both the distributions of the cost variables were further studied, and on the basis of Schwarz's Information Criteria (Schwarz, 1978) Beta distribution was considered to be more suitable for the analysis. Beta distribution is defined between 0 and 1, which is well in line with the fact that the costs were measured as shares of turnover, normally varying between 0 and 1. Because the survey methodology also allowed responses equal to zero, a small number (10^{-8}) was added to all the responses in the data in order to transform the distribution to include only positive values. To check the stability of the chosen distribution, the analysis was also performed by using a small number of (10^{-3}), which resulted in similar results.

Dependent variables other than logistics costs turned out either to be normally distributed, or to be transformable into a normally distributed variable.

SAS 9.3 proc. GLIMMIX was used for the analyses. Logistics costs were analysed on models assuming Beta distribution and a logarithmic link function, whereas the other dependent variables were analysed on models assuming normal distribution and an identity link function. The independent variables INTERNAL and EXTERNAL refer to internal environmental collaboration and external environmental collaboration, respectively, and SIZE, TECH, VALUE and MANSTRAT refer to the control variables.

3.4. Validity and reliability

Given that the variables used in this analysis concentrate only on environmental collaboration, the content validity of the used constructs hast to be acknowledged. The constructs of environmental collaboration were derived from previous research (Vachon and Klassen, 2008), which provides evidence of content validity. Further, a possibility exists that the respondents perceived the measures of environmental collaboration as elements of general collaboration in the supply chain. Previously, two sets of questions measuring internal and external collaboration in the supply chain were used in the Finland State of Logistics 2010 survey (Solakivi et al. 2010), but were not included in the Finland State of Logistics 2012 survey (Solakivi et al. 2012), which were used in this article. In order to check the validity of the measures a total of 100 respondents to Finland State of Logistics 2010 and 2012 were identified, and the correlations between the responses related to supply chain collaboration and environmental collaboration were compared. The correlations turned out to be small (0.26 for internal collaboration and 0.32 for external collaboration), which indicates that the measures used here do, in fact, measure environmental collaboration, and do not merely act as proxies for supply chain collaboration on a more general level.

Further, the items were subjected to confirmatory factor analysis. The composite reliabilities and average variances extracted of the constructs in the CFA are presented in Appendix 1. The CR's are over .9 and the AVE's over .6, which exceed the threshold values commonly used in the literature (see for example Fornell and Larcker 1981, Hair et al. 1998) and indicate the reliability of the constructs. Discriminant validity of the constructs was tested with the nested model test by first constraining the correlation parameter between the two constructs into 1 and then performing a chi-square difference test on the values obtained from the constrained and unconstrained models, as suggested by Jöreskog (1971). Further the test was performed for each pair of factors individually, as suggested by Anderson and Gerbing (1988).

The relatively low response rate raises concerns about non-response bias. Wagner and Kemmerling (2010) give a detailed summary of 229 survey studies in the field of logistics, which includes the respective response rates. Compared to their findings, the response rate of the Finland State of Logistics 2012 survey is well in line with other surveys on a similar scale. In addition, following the example of Armstrong and Overton (1977), the extrapolation technique was applied by considering the responses of the last response wave as closely resembling the "non-respondents". The responses of the first and last response wave were compared with Mann-Whitney U –test, which indicated that the profiles of the two groups did not significantly differ from each other. Thus, the risk of non-response bias was considered moderate. Given that most of the research variables were collected from the same source, e.g., through the same survey, a set of procedural remedies were implemented, as suggested by Podsakoff et al. (2003). In order to avert the possible consistency motive, the dependent and the independent variables were separated by placing them in different phases of the survey, using different scales, and assuring the respondents of confidentiality in order to avoid the social-desirability motive. Harman's single factor test was applied to these variables during the analysis, according to which the single factor explained only 17.4 per cent of the variance, which is below the critical value of 50 per cent, thereby excluding possible same-source bias.

4. The results of the analysis

Several statistically significant correlations emerged between the dependent and the independent variables. As hypothesised, there was a positive correlation between the measures of environmental collaboration, thus supporting Hypothesis 1. The correlations are presented in Table 2.

INSERT TABLE 2 HERE

Table 3 summarises the results of the models, presenting the statistically significant coefficients. The effect of environmental collaboration on logistics costs seems to depend on whether the collaboration is within the firm, with customers or with suppliers. No statistically significant effects between internal environmental collaboration and logistics costs could be identified.

Environmental collaboration with customers and suppliers on the other hand were found to be connected with logistics costs. More precisely, increasing environmental collaboration with customers was found to be associated with higher inventory carrying costs, logistics administration costs and other logistics costs. In addition, the connection between increased environmental collaboration was found to be connected with higher total logistics costs. Unlike in the case of collaboration with customers, collaboration with suppliers was found to be connected with lower inventory carrying costs, partly supporting hypothesis 3. The results of hypotheses testing are presented in Table 4.

INSERT TABLE 3 HERE

The effects of environmental collaboration on service performance are also dependent on whether the collaboration takes place within or outside the firm. Collaboration within the firm was found to be positively connected with supplier delivery time, which would indicate that increasing collaboration within the firm would be associated with longer supplier delivery time. Environmental collaboration was found to be negatively connected with supplier delivery accuracy. Taking into account the fact that a reflected transformation was used with the distribution of supplier delivery accuracy, the interpretation of the identified connection is the opposite. In fact, the results indicate that increasing collaboration with suppliers is associated with higher supplier delivery accuracy. Thus, Hypothesis 4 is also partly supported.

As with logistics costs and service performance, also the results concerning asset utilisation depend on whether the environmental collaboration takes place within the firm, or with suppliers or customers. Increasing collaboration with customers was found to be associated with less inventory days of supply. At the same time, increasing collaboration with suppliers was found to be associated with increased days of sales outstanding. The results concerning environmental collaboration within the firm were found to be mixed. Internal environmental collaboration was found to be associated with more inventory days of supply, more days of payables outstanding and longer cash to cash – cycle time. From the firm’s perspective, expanding the days of payables outstanding could be considered positive, whereas the other two connections could be considered negative. Thus, hypothesis 5 is also partly supported.

INSERT TABLE 4 HERE

Three measures were used to assess the effects of environmental collaboration and financial performance: Return on Capital Employed; Return on Sales; and Return on Assets. As in the case of logistics costs, the effects of environmental collaboration on financial performance seemed to depend on whether the collaboration was within the firm, or with suppliers and customers. The results indicate a negative effect of internal environmental collaboration on ROA, whereas increased collaboration with suppliers was found to have a positive effect on EBIT-% and increased collaboration with customers was found to be positively associated with ROA. Thus, Hypothesis 2 is also partly supported.

5. Discussion and conclusions

The focus in this article is on the effects of environmental collaboration on the performance of manufacturing firms. Even though previous literature has touched on performance from the supply chain perspective (see e.g. Vachon and Klassen, 2006), most of the analyses thus far concentrate on the effects of collaboration on the plant level and utilises only self-reported data. This research combines self-reported survey data with financial report-based data. Furthermore, previous research (e.g. Vachon & Klassen, 2008) on environmental collaboration has concentrated on collaboration with suppliers and customers. Hence, this article extends previous literature by adding measures on internal environmental collaboration in order to address all dimensions of collaboration, as suggested by Flynn et al. (2010).

The results of the confirmatory factor analysis confirmed the a-priori assumption that environmental collaboration comprises of three dimensions, collaboration within the firm and external collaboration further divided into collaboration with suppliers and customers. Previous literature posits a potential positive effect of environmental management and environmental collaboration on firm performance (e.g. Rao & Holt, 2005; De Giovanni & Esposito Vinzi, 2012; Yang et al., 2013; Zhu et al., 2013). On this basis, a set of hypotheses were derived addressing the connections between environmental collaboration and the different aspects of firm performance. The results of the analysis do not unambiguously support or reject such a positive effect. More precisely, it would seem that the nature of these effects depends on the nature of the collaboration, whether it is internal or external, and on the performance metric used.

In terms of logistics costs, internal environmental collaboration turned out to have no significant effects on any of the individual components, or on total costs. With regard to external environmental collaboration, the effect on logistics costs was found to be dependent on whether the environmental collaboration takes place with suppliers or customers. Increasing environmental collaboration with customers was found to be associated with higher inventory carrying costs, logistics administration costs, other logistics costs and total logistics costs. On the contrary, environmental collaboration with suppliers was found to be connected with lower inventory carrying costs. One reason might be that demand for environmentally friendly products and operations is transmitted through the supply chain: environmental compliance is required from the suppliers in order to address customer pressure. The results imply that environmental proactivity might be an additional cost and the actors in the supply chain try to reduce the negative financial effects by passing the additional costs upstream to their suppliers.

Vachon and Klassen (2008) and Zhu et al. (2008), for example, suggest that environmental collaboration should have positive effects on service performance and asset utilisation. While Vachon and Klassen (2008) observed that environmental collaboration with suppliers was linked with speed and delivery reliability, the results of this study only confirmed the latter: more extensive collaboration with suppliers resulted in higher delivery accuracy. Supplier delivery time, on the other hand, was found to be increased by internal collaboration. In order to achieve internal environmental goals, the focal firm might prefer slower and less polluting transport modes or consolidation of shipments, which in turn lengthens the delivery time. More extensive internal environmental collaboration was found to have a negative effect on asset utilisation, measured as cash-to-cash cycle time, as well as on one of its components - inventory days of supply. However, days of payables outstanding were increased. With regard to external environmental collaboration, supplier collaboration increased days of sales outstanding while customer collaboration decreased inventory days of supply. More frequent and accurate information sharing with customers might explain lower inventory days of supply. In terms of operational performance, firms should recognize the danger of concentrating too much on internal operations and simultaneously neglecting the supply chain perspective.

While Vachon and Klassen (2008), Yu et al. (2014) and Chavez et al. (2014) found that GSCM practices had a positive impact on flexibility, delivery, quality and cost, the results of this analysis were more mixed as both positive and negative connections were found. However, the results of Vachon and Klassen (2008), Yu et al. (2014) and Chavez et al. (2014) are based on samples of large North-American and Chinese manufacturers, whereas the present sample include also smaller firms.

The reason for the contradictory results might be that the small Finnish firms do not have similar resources to commit to environmental collaboration and hence the improvements in operational performance are also more limited. Considering this “liability of smallness”, the results would indicate that in order to successfully enjoy the benefits of increased collaboration, the firms should allocate sufficient resources for it.

In line with the findings from operational performance measures, the effects of environmental collaboration on financial performance would also seem to depend on whether the collaboration is within the firm or with suppliers and customers. Even more interestingly, the effects of customer collaboration on financial performance would seem to be the opposite than in the case of logistics costs. On the one hand, the results indicate that higher financial performance is associated with higher levels of supplier collaboration, measured as EBIT percentage, and customer collaboration, measured as ROA. On the other hand, lower financial performance measured as ROA is associated with higher levels of internal collaboration. This complements previous findings reported by King and Lenox (2002), Nakao et al. (2007), Clarkson et al. (2011) and Zhu et al. (2013) in further specifying the potentially beneficial and harmful effects of environmental efforts on financial performance.

In conclusion, the results of this research give no definite answer to the question of whether or not engaging in environmental collaboration pays off. Some of the hypotheses are fully supported, while support for some of the hypotheses depends on the type of the collaboration. Although internal environmental collaboration seems to have more negative than positive effects, the results by no mean indicate that internal environmental collaboration should be abandoned. The findings highlight the danger of neglecting the broader supply chain perspective. Environmental collaboration with suppliers and customers has mostly positive effects, thus supporting the results from traditional supply chain collaboration.

Moreover, this article focuses on the connections between environmental collaboration and firm performance in terms of either operational or financial measures, deliberately excluding environmental performance. One might assume that the goals of environmental collaboration relate more strongly to environmental performance than the more traditional measures of firm performance. Even though the results of this research do not contribute to the discussion on whether or not environmental collaboration is successful from the environmental perspective, they do indicate that there are ways in which firms can collaborate more intensively on environmental matters without compromising their cost competitiveness or financial performance. For the practitioners, the findings indicate that financial performance of the firms can be improved while addressing the environmental challenges. Especially this would seem to be the case, when the GSCM practices are expanded towards customers and suppliers. At the same time, further research is needed to analyse the effectiveness of environmental collaboration on the environmental performance of the firm.

In addition, environmental actions often impose costs in the short term while it might take a longer time horizon for the benefits to realize. Future research could address the effects of environmental collaboration on firm performance on a longitudinal basis. Further, just as most of the previous research, also this article is approaching the question of environmental collaboration and performance from a perspective of an individual firm. As such, the results provide recommendations for a focal firm on what to do and what to avoid in case an attempt to increase environmental performance through collaboration is made. At the same time, one has to acknowledge the limitation that the perspective is mainly limited to the focal firm, and merely suggest what the effects of collaboration for the entire supply chain might be. The question of whether environmental collaboration is truly beneficial for the entire supply chain or whether environmental collaboration is just a way to pass the costs of environmental efforts upstream the supply chain remains to be revealed by future research.

6. References

Ahi, P. and Searcy, C. (2013), "A comparative literature analysis of definitions for green and sustainable supply chain management", *Journal of Cleaner Production*, Vol. 52, pp. 329-341.

Anderson, S., Allen, J. and Browne, M. (2005), "Urban logistics-how can it meet policy makers' sustainability objectives", *Journal of Transport Geography*, Vol. 13, pp. 71-81.

Anderson, J.C. and Gerbing, D.W. (1988), "Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach", *Psychological Bulletin*, Vol. 103 No. 3, pp. 411-423.

Armstrong, J.S. and Overton, T.S. (1977), "Estimating Nonresponse Bias in Mail Surveys", *Journal of Marketing Research*, Vol. 14 No. 3, pp. 396-402

Aronsson, H. and Huge Brodin, M. (2006), "The environmental impact of changing logistics structures", *The International Journal of Logistics Management*, Vol. 17 No. 3, pp. 394-415.

Arvis, J.-F., Mustra, M.A., Ojala, L., Shepherd, B. and Saslavsky, D. (2012), "Connecting to Compete 2012, Trade Logistics in the Global Economy, The Logistics Performance Index and Its Indicators." World Bank, Washington, D.C.

Azevedo, S.G., Carvalho, H. and Machado, V.C. (2011), "The influence of green practices on supply chain performance: A case study approach", *Transportation Research Part E*, Vol. 47 No. 6, 850-871.

Barratt, M. (2004), "Understanding the meaning of collaboration in the supply chain", *Supply Chain Management: An International Journal*, Vol. 9 No. 1, 30-42.

Beamon, B. (1999a), "Designing the green supply chain", *Logistics Information Management*, Vol. 12 No. 4, pp. 332-342.

Beamon, B.M. (1999b), "Measuring Supply Chain Performance", *International Journal of Operations & Production Management*, Vol. 19 No. 3, pp. 275-292.

Biehl, M., Cook, W. and Johnston, D. A. (2006), "The efficiency of joint decision making in buyer-supplier relationships", *Annals of Operations Research*, Vol.145 No. 1, pp. 15-34.

Cao, M. and Zhang, Q. (2011), "Supply chain collaboration: impact on collaborative advantage and firm performance", *Journal of Operations Management*, Vol. 29 No. 3, pp. 163-180.

Carter, C.R. and Rogers, D.S. (2008), "A framework of sustainable supply chain management: moving toward a new theory", *International Journal of Physical Distribution and Logistics Management*, Vol. 38 No. 5, pp. 360-387.

Chavez, R., Yu, W., Feng, M. and Wiengarten, F. (2014), "The effect of customer-centric green supply chain management on operational performance and customer satisfaction", *Business Strategy and the Environment*, in press.

Chen, H., Mattioda, D.D. and Daugherty, P.D. (2007), "Firm-wide integration and firm performance", *The International Journal of Logistics Management*, Vol. 18 No. 1, pp. 5-21.

Chow, G., Heaver, T.D. and Henriksson, L.E. (1994), "Logistics performance: definition and measurement", *International Journal of Physical Distribution & Logistics Management*, Vol. 24 No. 1, 17-28.

Christopher, M. and Ryals, L. (1999), "Supply chain strategy: its impact on shareholder value", *The International Journal of Logistics Management*, Vol. 10 No. 1, pp. 1-10.

Clarkson, P.M., Li, Y., Richardson, G.D. and Vasvari, F.P. (2011), "Does it really pay to be green? Determinants and consequences of proactive environmental strategies", *Journal of Accounting and Public Policy,* Vol. 30 No. 2, pp. 122-144.

Darnall, N., Jolley, J., Handfield, R. (2008), "Environmental management systems and green supply chain management: Complements for sustainability?", *Business Strategy and the Environment,* Vol. 17 No. 1, 30-45.

De Giovanni, P. and Esposito Vinzi, V. (2012), "Covariance versus component-based estimations of performance in green supply chain management", *International Journal of Production Economics*, Vol. 135 No.2, pp. 907-916.

Dodd, S.; Bassi, A.; Bodger, K. and Williamson, P. (2006), "A comparison of multivariate regression models to analyse cost data", *Journal of Evaluation in Clinical Practice,* Vol. 12 No. 1, pp. 76-86.

Dyer, J.H. and Singh, H. (1998), "The relational view: cooperative strategy and sources of interorganizational competitive advantage", *Academy of Management Review*, Vol. 23 No. 4, pp. 660-679.

Elkington, J. (1997) *Cannibals with forks: the triple bottom line of 21st century business*. Capstone, Oxford.

Engblom, J., Solakivi, T., Töyli, J. and Ojala, L. (2012), "Multiple-method analysis of logistics costs", *International Journal of Production Economics,* Vol. 137 No. 1, pp. 29-35.

European Union (2014), "Factsheet: 7th EAP - General Union Environment Action Programme to 2020", available at: ec.europa.eu/environment/pubs/pdf/factsheets/7eap/en.pdf. (accessed 7.4.2014).

Fabbe-Costes, N. and Jahre, M. (2008), "Supply chain integration and performance: a review of the evidence", *The International Journal of Logistics Management*, Vol. 19 No. 2, pp. 130-154.

Fawcett, S.E. and Cooper, M.B. (1998), "Logistics performance measurement and customer success", *Industrial Marketing Management*, Vol. 27 No. 4, pp. 341-357.

Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance: a contingency and configuration approach", *Journal of Operations Management*, Vol. 28 No. 1, pp. 58-71.

Fornell and Larcker (1981), "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error", *Journal of Marketing Research,* Vol. 18 No.1, pp. 39-50.

Gimenez, C. and Ventura, E. (2005), "Logistics-production, logistics-marketing and external integration – Their impact on performance", *International Journal of Operations & Production Management*, Vol. 25 No. 1, pp. 20-38.

Gimenez, C., Sierra, V., Rodon, J. (2012) "Sustainable operations: Their impact on the triple bottom line", *International Journal of Production Economics*, Vol. 140 No. 1, pp. 149-159.

Golicic, S.L. and Smith, C.D. (2013), "A meta-analysis of environmentally sustainable supply chain management practices and firm performance", *Journal of Supply Chain Management*, Vol. 49 No. 2, pp. 78-95.

Gonzáles-Benito, J., Gonzáles-Benito, O. (2005), "Environmental proactivity and business performance: an empirical analysis", *Omega*, Vol. 33 No. 1, pp. 1-15.

Green, K.W. Jr., Zelbst, P.J., Meacham, J. and Bhadauria, V.S. (2012), "Green supply chain management practices: impact on performance", *Supply Chain Management: An International Journal*, Vol. 17 No. 3, pp. 290-305.

Grekova, K., Bremmers, H.J., Trienekens, J.H., Kemp, R.G.M. and Omta, S.W.F. (2013), "Extending environmental management beyond the firm boundaries: An empirical study of Dutch food and beverage firms", *International Journal of Production Economics*, in press.

Gujarati, D., Porter, D.C. (2009) *Basic Econometrics,* McgrawHill, Boston.

Gunasekaran, A., Patel, C. and McGaughey, R.E. (2004), "A framework for supply chain performance measurement", *International Journal of Production Economics*, Vol. 87 No. 3, pp. 333-347.

Gunasekaran, A., Lai, K. and Cheng, T.C.E. (2008), "Responsive supply chain: A competitive strategy in a networked economy", *Omega,* Vol. 36 No. 4, pp. 549-564.

Hair, J.F. Jr., Anderson, R.E., Tatham, R.L., and Black W. C. (1998). Multivariate Data Analysis (5th ed.). Upper Saddle River, New Jersey: Prentice Hall.

Hart, S.L. (1995), "A natural-resource-based view of the firm", *The Academy of Management Review*, Vol. 20 No. 4, pp. 986-1014.

Hervani, A.A., Helms, M.M. and Sarkis, J. (2005), "Performance measurement for green supply chain management", *Benchmarking: An International Journal,* Vol. 12 No. 4, pp. 330-353.

Hollos, D., Blome, C. and Foerstl, K. (2012), "Does sustainable supplier co-operation affect performance? Examining implications for the triple bottom line", *International Journal of Production Research*, Vol. 50 No. 11, pp. 2968-2986.

Jöreskog, K.G. (1971), "Statistical analysis of sets of congeneric tests", *Psychometrica*, Vol. 36 No. 2, pp. 109-133

Kahn, K.B. and Mentzer, J.T. (1996), "Logistics and interdepartmental integration", International Journal of Physical Distribution & Logistics Management, Vol. 26 No. 8, pp. 6-14.

Kim, S.-T. and Lee, S.-Y. (2012), "Stakeholder pressure and the adoption of environmental logistics practices: Is eco-oriented culture a missing link?", *The International Journal of Logistics Management*, Vol. 23 No. 2, pp. 238-258.

King, A.A. and Lenox, M.J. (2001), "Does It Really Pay To Be Green, An Empirical Study of Firm Environmental and Financial Performance", *Journal of Industrial Ecology*, Vol. 5 No. 1, pp. 105-116.

King, A.A. and Lenox, M.J. (2002), "The locus of profitable pollution reduction", *Management Science*, Vol. 48 No. 2, pp. 289-299.

Klassen, R.D. and McLaughlin, C.P. (1996), "The Impact of Environmental Management on Firm Performance", *Management Science*, Vol. 42 No. 8, pp. 1199-1214.

Kuik, S.S., Nagalingam, S.V. and Amer, Y. (2011), "Sustainable supply chain for collaborative manufacturing", *Journal of Manufacturing Technology Management*, Vol. 22 No. 8, pp. 984-1001.

Lai, K. and Wong, C.W.Y. (2012), "Green logistics management and performance: Some empirical evidence from Chinese manufacturing exporters", *Omega*, Vol. 40 No. 3, 267-282.

Leuschner, R., Rogers, D.S. and Charvet, F.F. (2013), "A meta-analysis of supply chain integration and firm performance", *Journal of Supply Chain Management*, Vol. 49 No. 2, pp. 34-57.

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

Lorentz, H. (2008), "Collaboration in Finnish-Russian supply chains. Effects on performance and the role of experience", *Baltic Journal of Management*, Vol. 3 No. 3, pp. 246-265.

Lorentz, H., Töyli, J., Solakivi, T., Hälinen, H.-M. and Ojala, L. (2012), “Effects of geographic dispersion on intra-firm supply chain performance”, *Supply Chain Management an International Journal*, Vol. 17 No. 6, pp. 611-626.

Markley, M.J. and Davis, L. (2007), “Exploring future competitive advantage through sustainable supply chains”, *International Journal of Physical Distribution & Logistics Management*, Vol. 37 No. 9, pp. 763-774.

Martinsen, U. and Björklund, M. (2012), “Matches and gaps in the green logistics market”, *International Journal of Physical Distribution & Logistics Management*, Vol. 42 No. 6, pp. 562-583.

Morgan, C. (2004), “Structure, speed and salience: performance measurement in the supply chain”, *Business Process Management Journal*, Vol. 10 No. 5, pp. 522-536.

Nakao, Y., Amano, A., Matsumura, K., Genba, K. and Nakano, M. (2007), “Relationship between environmental performance and financial performance: an empirical analysis of Japanese corporations”, *Business Strategy and the Environment*, Vol. 16 No. 2, pp. 106-118.

Nyaga, G.N., Whipple, J.M. and Lynch, D.F. (2010), “Examining supply chain relationships: Do buyer and supplier perspectives on collaborative relationships differ?”, *Journal of Operations Management*, Vol. 28 No. 2, pp. 101-114.

Patnayakuni, R., Rai, A. and Seth, N. (2006), ”Relational antecedents of information flow integration for supply chain coordination”, *Journal of Management Information Systems*, Vol. 23 No. 1, pp. 13-49.

Podsakoff, P.M., Mackenzie, S.B., Lee, J.-Y. and Podsakoff, N. (2003), “Common Method Biases in Behavioral Research: A Critical review of the Literature and Recommended Remedies”, *Journal of Applied* Psychology, Vol. 88 No. 5, pp. 879-903.

Porter, M.E. and van der Linde, C. (1995), “Green and competitive: ending the stalemate”, *Harvard Business Review*, Vol. 73 No. 5, pp. 120-134.

Quak, H.J. and de Koster, M.B.M. (2007), “Exploring retailers’ sensitivity to local sustainability policies”, *Journal of Operations Management*, Vol. 25 No. 6, pp. 1103-1122.

Quariguasi Frota Neto, J., Bloemhof-Ruwaard, J.M., van Nunen, J.A.E.E. and van Heck, E. (2008), “Designing and evaluating sustainable logistics networks”, *International Journal of Production Economics*, Vol. 111 No. 2, pp. 195-208.

Rao, P. and Holt, D. (2005), “Do green supply chains lead to competitiveness and economic performance”, *International Journal of Operations & Production Management*, Vol. 25 No. 9, pp. 898-916.

Sanders, N.R. and Premus, R. (2005), “Modeling the relationship between firm IT capability, collaboration, and performance”, *Journal of Business Logistics*, Vol. 26 No. 1, pp. 1-23.

Sarkis, J., Zhu, Q. and Lai, K.-H. (2011), “An organizational theoretic review of green supply chain management literature”, *International Journal of Production Economics*, Vol. 130 No. 1, 1-15.

Schramm-Klein, H. and Morschett, D. (2006), “The relationship between marketing performance, logistics performance and company performance for retail companies”, *International Review of Retail, Distribution and Consumer Research*, Vol. 16 No. 2, pp. 277-296.

Schwarz, G. (1978), “Estimating the dimension of a model”, *Annals of Statistics*, Vol. 6 No. 2, pp. 461-464.

Seuring, S. and Müller, M. (2008), "From a literature review to a conceptual framework for sustainable supply chain management", *Journal of Cleaner Production*, Vol. 16 No. 15, pp. 1699-1710.

Shi, V.G., Lenny Koh, S.C., Baldwin, J.and Cucchiella, F. (2012), "Natural resource based green supply chain management", *Supply Chain Management: An International Journal*, Vol. 17 No. 1, pp. 54-67.

Solakivi, T., Ojala, L., Töyli, J., Hälinen, H.-M., Lorentz, H., Rantasila, K., Huolila, K. and Laari, S. (2010), "Logistiikkaselvitys 2010", Publications of the Ministry of Transport and Communications Finland 36/2010.

Solakivi, T., Ojala, L., Lorentz, H., Laari, S. and Töyli, J. (2012), "Finland State of Logistics 2012", Publications of the Ministry of Transport and Communications Finland, 25/2012.

Srivastava, S.K. (2007), "Green supply-chain management: A state-of-the-art literature review", *International Journal of Management Reviews*, Vol. 9 No. 1, pp. 53-80.

Stank, T.P., Daugherty P.J. and Ellinger, A.E. (1999), "Marketing/logistics integration and firm performance", *The International Journal of Logistics Management*, Vol. 10 No. 1, pp. 11-24.

Stank, T.P., Keller, S.B. and Daugherty, P.J. (2001a), "Supply chain collaboration and logistical service performance", *Journal of Business Logistics*, Vol. 22 No. 1, pp. 29-48.

Stank, T.P., Keller, S.B. and Closs, D.J. (2001b), "Performance benefits of supply chain logistical integration", *Transportation Journal*, Vol. 41 No. 2/3, pp. 32-46.

Stewart, G. (1995), "Supply chain benchmarking study reveals keys to supply chain excellence", *Logistics Information Management*, Vol. 8 No. 2, pp. 38-44.

Testa, F. and Iraldo, F. (2010), "Shadows and lights of GSCM (Green Supply Chain Management): determinants and effects of these practices based on a multi-national study", *Journal of Cleaner Production*, Vol. 18 No. 10–11, pp. 953-962.

United Nations (1987), "Our common future, the world commission on environment and development", Oxford University press.

Vachon, S. and Klassen, R.D. (2006), "Extending green practices across the supply chain: The impact of upstream and downstream integration", *International Journal of Operations & Production Management*, Vol. 26 No. 7, pp. 795-821.

Vachon, S. and Klassen, R.D. (2008), "Environmental management and manufacturing performance: The role of collaboration in the supply chain", *International Journal of Production Economics*, Vol. 111 No. 2, pp. 299-315.

Wagner, M. (2005), "How to reconcile environmental and economic performance to improve corporate sustainability: corporate environmental strategies in the European paper industry", *Journal of Environmental Management*, Vol. 76 No. 2, pp. 105-118.

Walker, H., Di Sisto, L. and McBain, D. (2008), "Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors", *Journal of Purchasing & Supply Management*, Vol. 14 No. 1, pp. 69-85.

Wagner, S.M. and Kemmerling, R. (2010), "Handling nonresponse in logistics research", *Journal of Business Logistics*, Vol. 31 No. 2, pp. 357-381.

Wang, Z. and Sarkis, J. (2013), "Investigating the relationship of sustainable supply chain management with corporate financial performance", *International Journal of Productivity and Performance Management*, Vol. 62 No. 8, pp. 871-888.

Watson, K., Klingenberg, B., Polito, T. and Geurts, T. (2004), ”Impact of environmental management system implementation on financial performance”, *Management of Environmental Quality*, Vol. 15 No. 6, pp. 622-628.

Webster’s Third New International Dictionary (1966), William Benton, Chicago.

Whicker, L., Bernon, M., Templar, S., Mena, C. (2009) Understanding the relationships between time and cost to improve supply chain performance, *International Journal of Production Economics*, Vol. 121, No.2, pp. 641-650.

World Bank (2012). “World Development Indicators”, available at: http://data.worldbank.org/data-catalog/world-development-indicators (accessed 12.5.2014).

World Economic Forum (2013), “The Global Competitiveness Report 2012-2013, Full Data Edition”, available at: http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf (accessed 12.5.2014).

Wu, H. and Dunn, S. (1995), “Environmentally responsible logistics systems”, *International Journal of Physical Distribution and Logistics Management*, Vol. 25 No. 2, pp. 20-38.

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*, Vol. 35 No. 4, pp. 493-504.

Yang, C.-S., Lu, C.-S., Haider, J.J. and Marlow, P.B. (2013), “The effect of green supply chain management on green performance and firm competitiveness in the context of container shipping in Taiwan”, *Transportation Research Part E*, Vol. 55, pp. 55-73.

Yu, W., Chavez, R., Feng, M. and Wiengarten, F. (2014), “Integrated green supply chain management and operational performance”, *Supply Chain Management: An International Journal*, Vol. 19 No. 5/6, pp. 683-696.

Zacharia, Z.G., Nix, N.W. and Lusch, R.F. (2009), “An analysis of supply chain collaborations and their effect on performance outcomes”, *Journal of Business Logistics*, Vol. 30 No. 2, pp. 101-123.

Zhu, Q. and Sarkis, J. (2004), “Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises”, *Journal of Operations Management*, Vol. 22 No. 3, pp. 265-289.

Zhu, Q., Sarkis, J. and Lai, K. (2008), “Confirmation of a measurement model for green supply chain management practices implementation”, *International Journal of Production Economics*, Vol. 111 No. 2, pp. 261-273

Zhu, Q., Sarkis, J. and Lai, K. (2012), “Examining the effects of green supply chain management practices and their mediations on performance improvements”, *International Journal of Production Research*, Vol. 50 No. 5, pp. 1377-1394.

Zhu, Q., Sarkis, J.and Lai, K. (2013), “Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices”, *Journal of Purchasing & Supply Management*, Vol. 19 No. 2, pp. 106-117.

Figure 1. Summary of the research hypotheses

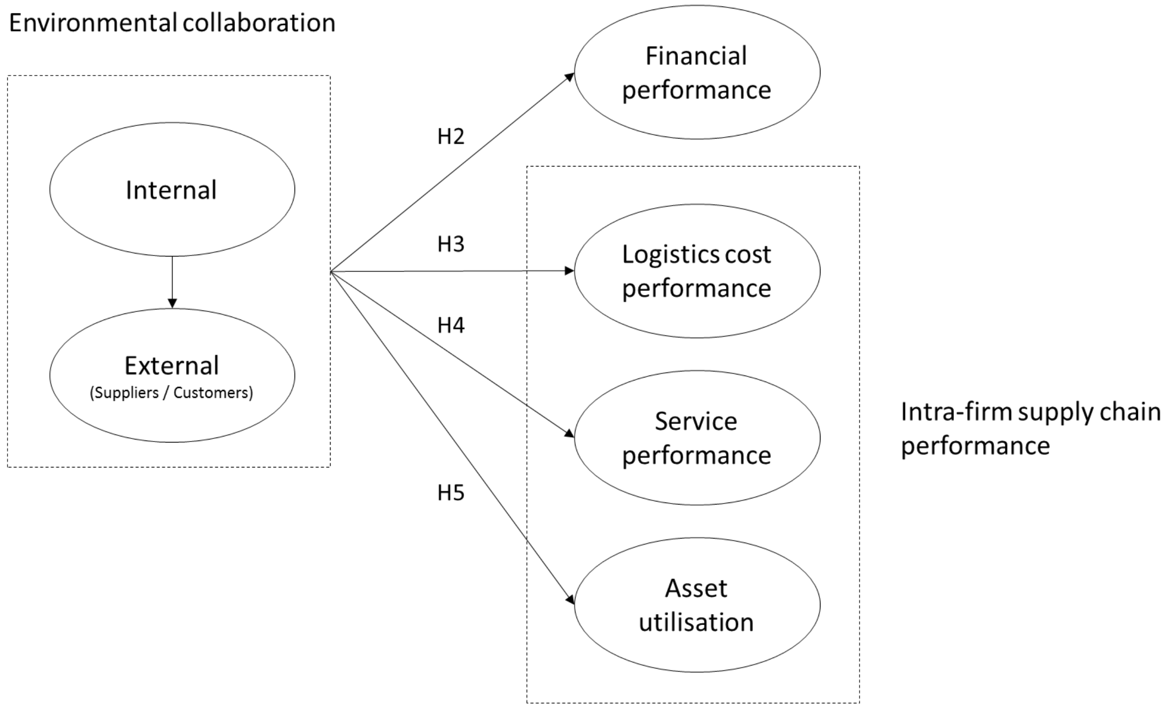
Environmental collaboration
Internal
External
(Suppliers / Customers)
H2
H3
H4
H5
Financial performance
Logistics cost performance
Service performance
Asset utilisation
Intra-firm supply chain performance

Table 1. Research variables

Constructs	*Operationalisation of variables*	*Variable name*
Dependent: Intra-firm supply chain performance		
Logistics costs	*Transportation costs* (% of turnover)	TRAN
	Warehousing costs (% of turnover)	WARE
	Inventory costs (% of turnover)	INV
	Logistics administration costs (% of turnover)	ADMIN
	Other logistics costs (% of turnover)	OTHER
	Total logistics costs (% of turnover)	TOTAL
Service performance	*Perfect order fulfilment* (% of orders)	POF
	Order delivery cycle time (average days from order to delivery)	OFCT
	Supplier delivery accuracy	SDA
	Supplier delivery time	SDT
Asset utilisation	*Inventory days of supply* (average days material owned, from purchase to sale)	DOS
	Cash-to-cash cycle time (in days; inventory days of supply + days of sales outstanding - days of payables outstanding)	CCC
Dependent: Financial performance		
	Return on Capital Employed	ROCE
	Return on Assets	ROA
	Earnings Before Interest and Taxes (%)	EBIT -%
Independent: Environmental collaboration		
Internal environmental collaboration	Sum of: We have set environmental goals to ourselves There is a mutual understanding of responsibilities regarding environmental performance We have worked together to reduce environmental impact of our activities We have conducted joint planning to anticipate and solve environmental-related problems We have worked together to reduce environmental impact of our products	INTER
Collaboration with suppliers	Sum of: We've worked together to achieve environmental goals collectively with our key suppliers There is a mutual understanding of responsibilities regarding environmental performance We have worked together to reduce environmental impact of our activities We have conducted joint planning to anticipate and solve environmental-related problems We have worked together to reduce environmental impact of our products Collaboration with customers	SUPPL
Collaboration with customers	Sum of: We've worked together to achieve environmental goals collectively with our key customers There is a mutual of responsibilities regarding environmental performance We have worked together to reduce environmental impact of our activities We have conducted joint planning to anticipate and solve environmental-related problems We have worked together to reduce environmental impact of our products	CUST
Control		
Firm size	*0= turnover from 2 to €50 million , 1= turnover more than €50 million*	SIZE
Manufacturing strategy	*0= push/ MTS, 1=pull/ ATO, MTO, ETO*	MANSTRAT
Industry orientation	*0= technology industry, 1= other industries*	VALUE
Value added	*Average value added percentage of the industry 0= below Finnish average, 1 above Finnish average*	TECH

Table 2. Pearson correlation coefficients of the independent and dependent variables

		Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Internal environmental collaboration[a]	19.6	4.4																			
2	Environmental collaboration with suppliers[a]	16.1	5.2	,679**																		
3	Environmental collaboration with customers[a]	16.5	5.4	,606**	,838**																	
4	Transportation costs	6.7	6.8	.149	,170*	.100																
5	Warehousing costs	3.1	3.5	.040	.070	.076	,231**															
6	Inventory carrying costs	5.1	7.5	.013	-.047	.035	.119	,470**														
7	Logistics administration costs	2.0	3.4	.076	.094	,202*	,250**	,495**	,440**													
8	Other logistics costs	2.1	4.4	.012	.085	,175*	.117	,297**	,312**	,578**												
9	Total logistics costs	19.0	15.5	.126	.125	.150	,578**	,562**	,717**	,610**	,518**											
10	Perfect order fulfillment	88.3	20.9	.054	.014	-.062	-.013	.016	-.096	-.140	-.091	.014										
11	Order-delivery cycle time	49.9	128.4	-.078	.009	.085	-,203*	-,188*	-.118	-.155	-.063	-,291**	-,198*									
12	Supplier delivery accuracy	85.2	22.6	-.132	-.116	-.133	-.059	-.016	.029	-.059	-.003	.058	,510**	-,266**								
13	Supplier delivery time	24.7	38.1	,231**	.126	.106	-,195*	-.014	-.047	-.083	-.060	-.148	-.077	,403**	-,204*							
14	Days of sales outstanding	32.7	18.1	,262**	,184*	,189*	.014	.082	.053	.071	.003	.021	-.092	.067	-.137	,376**						
15	Inventory days of supply	51.7	56.6	.137	.020	-.005	-.132	-.063	-.103	-.136	-.156	-,217*	-.104	,335**	-,219*	,558**	,332**					
16	Days of payables outstanding	27.8	16.2	,184*	.167	.155	-.054	-.035	-,196*	.047	-.097	-,177*	.015	.088	.072	,351**	,462**	,209*				
17	Cash to cash -cycle time	57.1	61.2	.158	.022	.015	-.102	.026	.005	-.108	-.139	-.144	-.104	,326**	-,226**	,503**	,489**	,921**	.070			
18	Return on Capital Employed	14.2	34.1	-.062	-.071	-.024	-,199*	-.057	-.130	-.042	.076	-.121	.010	-.054	-.080	-.039	.130	.016	-.190	.083		
19	Ebit-%	5.2	9.4	.011	.077	.043	-,231*	-.010	-.153	-.072	-.053	-,179*	.100	.033	-.074	.014	,235*	.137	-.033	,232*	,803**	
20	Return on Assets	8.1	17.3	-.033	-.009	-.029	-.152	-.038	-.119	-.017	.039	-.106	.041	-.050	-.072	-.055	.162	.063	-.135	.149	,915**	,880**

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level, [a] indicates independent variable

Table 3. Model-based results

	Used distribution	Dependent variable	Link function	Transformation	Coefficients. INTERNAL	SUPPL	CUST	SIZE	MANSTRAT	TECH	VALUE
Logistics costs	Beta	Transportation costs	Logit	-				**			
	Beta	Warehousing costs	Logit	-						**	**
	Beta	Inventory carrying costs	Logit	-		-0.10**	0.12**			**	
	Beta	Logistics administration costs	Logit	-			0.08**				
	Beta	Other logistics costs	Logit	-			0.06**				*
	Beta	Total logistics costs	Logit	-			0.03**		**		
Customer service performance	Normal	Perfect order fulfillment	Identity	logref						**	
	Normal	Order delivery cycle time	Identity	log				**	**	**	
	Normal	Supplier delivery accuracy	Identity	logref		-0.04**				*	
	Normal	Supplier delivery time	Identity	log	0.02**					**	**
Asset utilisation	Normal	Days of sales outstanding	Identity	log		0.01**			**	**	**
	Normal	Inventory days of supply	Identity	log	0.03**		-0.01*			**	
	Normal	Days of payables outstanding	Identity	log	0.007*			**		*	
	Normal	CashTo Cash	Identity	-	2.14*					*	
Financial performance	Normal	ROCE	Identity	-							**
	Normal	EBIT-%	Identity	-		0.277*					
	Normal	ROA	Identity	-	-0.8*		0.71*	*			

** significant on 0.05 level

* significant on 0,1 level

Table 4. Summary of the research hypotheses

	Supported	Partly supported	Not supported
Hypothesis 1. As internal environmental collaboration increases, external environmental collaboration also increases	X		
Hypothesis 2. As environmental collaboration increases, the firm's financial performance improves		X	
Hypothesis 3. As environmental collaboration increases, the firm's logistics cost performance improves		X	
Hypothesis 4. As environmental collaboration increases, the firm's service performance improves		X	
Hypothesis 5. As environmental collaboration increases, the firm's asset utilization improves		X	