Supply chain integration and its impact on sustainability

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Abstract

Purpose – The purpose of this paper is to examine the role of supply chain integration (SCI) in improving sustainability management practices (SMPs) and performance.
Design/methodology/approach – Based on data collected from 931 manufacturing firms in multiple countries and regions, the authors conducted a structural equation modeling analysis to test the proposed hypotheses.
Findings – The findings suggest that supplier and customer integration are vital enablers for both intra- and inter-organizational SMPs. The results also reveal that both intra- and inter-organizational SMPs are significantly and positively associated with sustainability performance (i.e. economic, environmental and social performance) and function as complements to jointly enhance environmental and social performance.
Originality/value – This study incorporates SCI into the sustainability literature, providing a new perspective on sustainability and supply chain management research.

Keywords Supply chain integration, Sustainability performance, Sustainability management practices
Paper type Research paper

1. Introduction

Over the past few decades, as firms have vigorously pursued competitive advantages within the turbulent global business environment, the importance of sustainability to a firm's bottom line has steadily grown (Kleindorfer *et al.*, 2005; Lubin and Esty, 2010). Commensurate with the increasing importance of sustainability, supply chain researchers have examined whether extending sustainability issues into a firm's supply chain (which is beyond its internal operations) is a crucial step in improving its sustainability performance (Beske and Seuring, 2014; Seuring and Müller, 2008; Winter and Knemeyer, 2013). In this regard, given the complex and global nature of sustainability issues, one of the expanding areas of interest has been whether companies understand the importance of collaboration within their supply chains (Kiron *et al.*, 2015). Because there are three dimensions to supply chain integration (SCI) (i.e. internal, supplier and customer integration) that comprise strategic collaboration with internal and external supply chain partners (Flynn *et al.*, 2010; Bill *et al.*, 2016), SCI may play an important role in improving sustainability management practices (SMPs) and performance.

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Despite the growing research on sustainable supply chain management, it is still unclear how manufacturing firms cooperate with supply chain partners to achieve their desired sustainability performance. Several sustainability studies have examined external pressure as a main driver of firm sustainability (Dimaggio and Powell, 2000; Liu *et al.*, 2010; Sarkis *et al.*, 2010). However, little research has been conducted on how manufacturers adopt SCI activities to facilitate their SMPs and enhance their sustainability performance. Research has investigated the positive influence of customer integration (Gelhard and von Delft, 2016), supply management capabilities (Bowen *et al.*, 2001) and strategic purchasing in supply management (Paulraj, 2011) on SMPs or sustainability performance, indirectly representing a possible link between SCI and sustainability.

This study recognizes the need to further investigate the interrelationship between internal and external SCI and a firm's supply chain activities to improve sustainability. It is important to explore a research framework within which SCI is a valuable enabler of a firm's sustainability practices and performance. This study thus seeks to answer the following research questions:

RQ1. How do the three dimensions of SCI influence SMPs?

RQ2. How do SMPs influence manufacturing firms' sustainability performance?

By answering these important questions, this study, which extends sustainability research into supply chains, makes the following contributions. First, it provides new perspectives from which to understand the important role of SCI in improving intra- and inter-organizational SMPs and sustainability performance. Second, it provides practical insights into the ways manufacturers successfully implement SCI and SMPs to achieve their desired sustainability performance.

2. Theoretical background and hypotheses development

We examined the literature related to SCI and SMPs to develop the theoretical background for this study. In the following sections, we discuss each construct and develop hypotheses on how they are related.

2.1 Supply chain integration (SCI)

SCI refers to "the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes. The goal is to achieve the effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer at low cost and high speed" (Flynn *et al.*, 2010, p. 59). The three dimensions of SCI (i.e. internal, supplier and customer integration) have been widely accepted in the literature (Flynn *et al.*, 2010; Wong *et al.*, 2011; Zhao *et al.*, 2011). Internal integration can be defined as "the degree to which a manufacturer structures its own organizational strategies, practices and processes into collaborative, synchronized processes, in order to fulfill its customers' requirements and efficiently interact with its suppliers" (Flynn *et al.*, 2010, p. 59). Internal integration within a firm requires data and information system integration that enables firms to integrate activities within different functional areas (Kim, 2009; Zhao *et al.*, 2011), including information sharing, collaboration and joint decision making among the different functions (Williams *et al.*, 2013). Through cross-functional information sharing and collaboration, internal integration facilitates functional goal alignment and responsiveness (Williams *et al.*, 2013), thereby leading to better outputs, such as operational performance (Lotfi *et al.*, 2013; Williams *et al.*, 2013; Wong *et al.*, 2011), competitive capabilities (Antonio *et al.*, 2009) and firm performance (Huo, 2012; Swink *et al.*, 2007).

External integration can be defined as the degree to which a manufacturer joins with its external partners to structure inter-organizational strategies, practices and processes into

collaborative, synchronized processes (Zhao *et al.*, 2011). These mainly involve information sharing, system coupling, close collaboration and joint decision making with key suppliers and key customers (Huo *et al.*, 2015; Sun and Ni, 2012; Wiengarten *et al.*, 2014; Yang *et al.*, 2016). Internal integration focuses on cross-functional cooperation within companies, whereas external integration focuses on inter-organizational cooperation among supply chain partners. In this way, the entire supply chain is fully covered and managed through both internal and external integration.

2.2 Sustainability management practices (SMPs)

Firms wanting to improve sustainability pursue both intra- and inter-organizational SMPs.

Intra-organizational SMPs. Firms have increasingly adopted internal operational practices that enhance sustainability at the company level. One of these practices is environmental management, which aims to save costs related to environmental pollution (Lucas and Noordewier, 2016). Activities like reusing, recycling and remanufacturing can foster sustainability so that product recovery and reuse minimize the negative environmental impact of waste disposal, extraction of raw materials, transportation and distribution. Another internal operational practice enhances the social dimension of sustainability by improving employee well-being (Pagell and Gobeli, 2009; Voorde *et al.*, 2012). Pagell and Gobeli reported that employee well-being practices were positively related to operational performance. Because workplace accidents and injuries have steadily grown over the past decade, maintaining workplace safety has become important to protecting employees' health and safety and promoting their welfare (Das *et al.*, 2008; Okun *et al.*, 2016). Good health and safety conditions are crucial to firms pursuing sustainability (Jørgensen, 2008). Pagell and Gobeli examined employee well-being by focusing on organizations' records related to protecting employee health and safety (evidenced by records of safety violations). Vachon and Klassen (2008) used fair labor practices connected to the workplace and employee well-being to measure social equity within human resource operations and company strategies.

Inter-organizational SMPs. Companies' efforts to address sustainability have extended beyond their internal operations to their suppliers' capabilities and to helping suppliers meet sustainability standards that satisfy their customers' sustainability expectations. Incidents such as the Mattel toy recall (2007) and Unilever's palm oil contract suspension suggest that a supplier's failure to meet environmental standards can have a substantial negative impact on the focal company, such as immediate financial loss and long-term damage to the company's reputation (Zhang *et al.*, 2011). Firms like Nike and Adidas have struggled to address social equity issues such as inhumane working conditions (Seuring and Müller, 2008). These environmental and social problems have primarily come from suppliers who have been beyond their direct control. Thus, firms have increasingly realized the importance of engaging with supply chain partners to better manage sustainability. Focal firms have progressively recognized the strategic importance of incorporating sustainability considerations in managing their major suppliers' performance (Gimenez and Tachizawa, 2012).

2.3 Relationship between SCI and SMPs

Gimenez and Tachizawa (2012) suggested that both internal and external factors enabled firms to facilitate sustainability practices. They defined enablers as the "factors that assist firms in achieving sustainability practices" (p. 537). Internal enablers include but are not limited to the firm's environmental commitment, top management support, resource availability, purchasing personnel's supply management capability and proper performance measurement systems. External enablers include supply chain-related capabilities such as

trust, national culture and logistical and technological integration. Because SMPs require coordination across all of their supply chain partners, having a high degree of internal and external SCI to support a firm's supply management capability serves as an important enabler in facilitating its SMPs (Pullman *et al.*, 2009).

Supplier integration has been one of the key functional practices within the supply chain (Perols *et al.*, 2013; Zhang *et al.*, 2015). To maintain quality and long-term strategic relationships, managing suppliers has long included the sharing of key information, involving suppliers in the product development process and developing supplier programs (Li *et al.*, 2005). Firms form strategic partnerships with major suppliers and maintain long-term healthy relationships by developing mutual trust and a compatible culture in addition to sharing their vision and information. Given the increasing importance of the supplier's role in SMPs, such strategic partnerships have become an important enabler of SMPs (Paulraj, 2011; Wilding *et al.*, 2012).

Collaborative activities with suppliers along the supply chain can also help focal firms to identify multiple sustainability challenges (Huq *et al.*, 2016; Klassen and Vachon, 2003). Elkington (1998) explored how effective long-term partnerships with suppliers were crucial to companies making the transition to sustainability. Bowen *et al.* (2001) studied green supply management capabilities and found that bundles of supply chain practices facilitated the implementation of green supply chains. These bundles include cross-functional liaisons, purchasing policies and procedures, supplier partnerships and purchasing and environmental technical skill literacy (e.g. advanced understanding of environmental issues and how they affect supply). Vachon and Klassen (2008) further reported that collaborative environmental activities with supply chain members (such as joint environmental goal setting, shared environmental planning and working together to reduce pollution or other environmental effects) positively affected manufacturing performance. In sum, collaborative approaches and information sharing with suppliers are necessary to facilitating both intra- and inter-organizational SMPs.

Firms wanting to improve sustainability pursue both intra- and inter-organizational SMPs that enhance it. Intra-organizational SMPs refer to internal operational practices that enhance sustainability at the company level. However, companies' efforts to address sustainability have not remained exclusively internal. They have also looked outward to inter-organizational SMPs that help their suppliers meet sustainability standards and satisfy their customers' sustainability expectations. Because supplier integration is characterized by strategic collaboration, it may serve as a vital enabler in facilitating firms' successful implementation of intra- and inter-organizational SMPs. Thus, we suggest the following hypotheses:

H1a. Supplier integration is positively associated with a firm's intra-organizational SMPs.

H1b. Supplier integration is positively associated with a firm's inter-organizational SMPs.

Customer integration helps firms build long-term customer relationships and improve the overall satisfaction of their customers. Through customer integration practices, firms are more likely to understand their customers by accessing direct information on their needs and requirements (Gelhard and von Delft, 2016). In the sustainability era, recognizing and satisfying customer need is critical. Firms that integrate customers into their operational and supply chain activities can achieve greater profitability by delivering quality products and services while maintaining social and environmental sustainability. Furthermore, they are better prepared for future customers. Specifically, a major driver of SMPs is external stakeholder and customer pressure (Paulraj, 2011). Integration practices that include a firm's major customers can help to promote inter-organizational information flow, enabling the firm to more efficiently identify its customers' economic needs and environmental and social concerns (Gelhard and von Delft, 2016). These insights can subsequently lead to the implementation of SMPs. Because customer pressure promotes SMPs across all of a firm's

supply chain members (Pullman *et al.*, 2009), customer integration may play an important role in implementing both intra- and inter-organizational SMPs. The following hypotheses are thus posited:

H2a. Customer integration is positively associated with a firm's intra-organizational SMPs.

H2b. Customer integration is positively associated with a firm's inter-organizational SMPs.

Internal integration is focused on breaking down functional barriers through activities, including information sharing, joint decision making and cross-functional teamwork (Flynn *et al.*, 2010). By improving horizontal linkages across internal functional units, internal integration fosters information sharing and collaboration between different functions (Antonio *et al.*, 2009; Zhao *et al.*, 2011). The successful implementation of SMPs requires new capabilities and skills, changes in organizational objectives and organizational structures that are more suited to sustainability. Through cross-functional teamwork and collaboration, internal integration may play a central role in developing new skills and competencies related to sustainability (Wolf, 2013, 2014). In addition, internal integration promotes the alignment of functional practices and goals with strategic business priorities (e.g. sustainability) (Narasimhan and Das, 2001). Such alignment may help to transform a firm's sustainability priorities into operational practices through cross-functional collaboration, rendering the organizational structure more suitable for sustainability. Therefore, we make the following hypotheses:

H3a. Internal integration is positively associated with a firm's intra-organizational SMPs.

H3b. Internal integration is positively associated with a firm's inter-organizational SMPs.

2.4 Relationships between SMPs and sustainability performance

The positive link between internal environmental management practices and pertinent sustainability performance indicators has been well recognized (Pullman *et al.*, 2009; Yang *et al.*, 2011; Zhu and Sarkis, 2004). For example, environmental practices that allow an organization to design eco-friendly products can reduce their impact on the environment and improve environmental performance (Hammouri *et al.*, 2009). Similarly, environmental recycling practices help firms reuse, recycle, and remanufacture materials, components, and returned products, facilitating their environmental friendliness (Sarkis *et al.*, 2010). This is evidenced by the recycling practices of Wal-Mart, 3M and Starbucks.

Employee health and safety systems aim to boost employee well-being (Pagell and Gobeli, 2009). A firm's employee well-being practices are positively related to improvement of the environment and better overall sustainability performance outcomes (Rothenberg *et al.*, 2001). Scholars have supported the notion that employee-related practices directly associated with positive employee attitudes and satisfaction lead to overall improvements in quality (Flynn *et al.*, 1995). A firm's activities aimed at enhancing internal operational health and safety also can improve its brand image (Pagell and Gobeli, 2009). Therefore, we contend that internal employee practices are positively associated with sustainability performance. We posit the following hypothesis:

H4. A firm's intra-organizational SMPs are positively associated with sustainability performance.

Using proper evaluation schemes to monitor and evaluate suppliers on whether they meet sustainability standards protects companies from potential risks related to environmental damage and violations of social standards (Koplin *et al.*, 2007). Thus, monitoring may prevent unnecessary financial loss due to the high probability that supplier evaluations improve environmental performance and bring about positive economic performance.

Furthermore, overseeing the qualifications of suppliers during the evaluation process helps organizations manage their reputations and corporate legitimacy (Bai and Sarkis, 2010), thereby improving social performance.

Developing the long-term capacity of suppliers to meet increasingly complex sustainability standards has been a smart solution to the rising level of supplier-related accidents in many countries. Firms that offer education and training programs to transfer knowledge corresponding to sustainability criteria are more likely to build mutual trust with their suppliers and enhance their economic, environmental and social performance. Engaging in joint activities with suppliers along the supply chain can help a company identify the multiple challenges that arise from sustainability issues, including those of an environmental and social nature (Yang *et al.*, 2010). Although investing resources to improve suppliers' knowledge of sustainability standards may be costly and require a prolonged timeframe, such activities bring sustainable power to a company, allowing it to deal with unexpected disruptions that may destroy its entire supply chain. Therefore, we make the following hypothesis:

H5. A firm's inter-organizational SMPs are positively associated with sustainability performance.

3. Research methods and data analyses

3.1 Data collection and sampling

To empirically test the proposed hypotheses, data collected from the six round international manufacturing strategy survey (IMSS-VI) were used. The IMSS is a worldwide research project that has surveyed the strategies, practices and performances of manufacturing firms worldwide (Yang *et al.*, 2011). IMSS-VI was conducted between 2013 and 2014, during which data were collected from 22 countries and regions, with good coverage in America, Asia and Europe. After dropping samples with over 60 percent missing data, a total of 931 samples were released and used in the statistical analysis of this study. To ensure face and content validity, the research team carefully selected measurement items from the IMSS database based on the literature. The Appendix provides a list of the survey items used in this study.

In this study, SCI includes customer, supplier and internal integration. Based on previous SCI studies (Quesada *et al.*, 2008; Sun and Ni, 2012; Wiengarten *et al.*, 2014; Yang *et al.*, 2016), customer and supplier integration were each measured by collaborative approaches, information sharing, joint decision making and system coupling with key customers and suppliers. Internal integration was measured by joint decision making and information sharing with purchasing and sales departments according to Yang *et al.* (2016) and Narasimhan and Kim (2002).

This study classified a firm's intra-organizational SM practice and inter-organizational SMPs as two forms of SMP. Based on the work of Pagell and Gobeli (2009), intra-organizational SM practice was operationalized across the environmental and employee well-being aspects of SM practice. Inter-organizational SMPs were measured by supplier assessment and collaboration in sustainability issues, according to the work of Gualandris and Kalchschmidt (2014) and Wilding *et al.* (2012).

Following the triple bottom line perspective of Elkington (2010) and Carter and Rogers (2008), sustainable performance was operationalized as a second-order factor including environmental, social and economic performance. Environmental performance was measured by indicators covering materials, water and/or energy consumption and pollution emission and waste production levels (Golini *et al.*, 2014; Paulraj, 2011). Social performance was measured by indicators covering worker motivation and satisfaction and health and safety conditions (Carter and Jennings, 2002; Golini *et al.*, 2014; Paulraj, 2011). Finally, economic performance was measured across the dimensions of manufacturing costs and efficiency (Gimenez, Sierra and Rodon, 2012).

Firm size was used as a control variable. In general, large firms with resource availability and business process capabilities tend to be better at implementing SMPs and achieving sustainability performance than small firms (Gualandris and Kalchschmidt, 2014). We used firm size as a natural logarithm of the number of employees.

Because the data were collected using single informants, we conducted Harman's single-factor test to assess common method variance. Researchers typically use Harman's single-factor test to assess common method variance. This technique assumes that when there is a large amount of common method variance, either one factor will emerge from factor analysis or one general factor will explain most of the covariance among the measures (Podsakoff *et al.*, 2003; Podsakoff and Organ, 1986). The EFA result revealed eight distinct factors with eigenvalues above 1.0, explaining 74.229 percent of the total variance. The first factor explained 13.148 percent of the variance, but did not explain most of the total variance. The results suggest common method variance was not a serious problem in our analysis.

3.2 Construct validity

We conducted confirmatory factor analysis to validate our measures and confirm the proposed factor structure. Table I presents the fit statistics for the first- and second-order measurement models. The fit indices show an acceptable fit for the models. The loadings for the first-order measurement model ranged from 0.607 to 0.881, providing evidence of convergent validity. According to the test suggested by Zait and Bertea (2011), we assessed discriminant validity by testing whether the square root of the average variance extracted (AVE) value for each construct was greater than the correlation between the latent variables (Fornell and Larcker, 1981). Table II presents the means, standard deviations and

Fit indices	Measurement model (first order)	Measurement model (second order)	Structural model	Recommended values
χ^2	979.265	1,044.908	1,269.518	
df	247	257	282	
χ^2/df	3.965	4.066	4.502	$< 2^a - < 5^b$
RMSEA	0.056	0.057	0.061	$\leqq 0.08^c$; $\leqq 0.05^d$
GFI	0.921	0.916	0.905	$> 0.9^d$
CFI	0.940	0.935	0.919	$> 0.9^d$
NFI	0.921	0.916	0.899	$> 0.9^d$
IFI	0.940	0.935	0.920	$> 0.9^d$

Notes: $n = 931$. [a]Tabachnick and Fidell (2013); [b]Schumacker and Lomax (2004); [c]Handley and Benton (2009); [d]Hu and Bentler (1999)

Table I.
Fit statistics for validating measurement model

	Mean	SD	1	2	3	4	5	6	7	8
1. Supplier integration	3.04	0.860	*0.56*							
2. Customer integration	2.94	0.937	0.68**	*0.60*						
3. Internal integration	3.55	0.859	0.40**	0.39**	*0.68*					
4. Intra-organizational SMPs	3.34	0.942	0.39**	0.39**	0.43**	*0.58*				
5. Inter-organizational SMPs	2.80	1.041	0.46**	0.45**	0.37**	0.61**	*0.63*			
6. Environmental performance	3.19	0.591	0.14**	0.12**	0.15**	0.24**	0.27**	*0.71*		
7. Social performance	3.41	0.645	0.25**	0.24**	0.26**	0.38**	0.36**	0.32**	*0.68*	
8. Economic performance	3.08	0.563	0.14**	0.08*	0.15**	0.17**	0.21**	0.40**	0.20**	*0.62*
9. Firm size	6.03	1.720	0.20**	0.15**	0.11**	0.25**	0.18**	0.05	0.05	0.04

Notes: $n = 931$. Values on the diagonal indicate AVE. *$p < 0.05$; **$p < 0.01$

Table II.
Descriptive statistics, inter-construct correlations and AVEs

correlations between the constructs and the AVE. The results show that all of the square roots of the AVE were larger than the corresponding correlations, providing strong support for discriminant validity. With regard to the internal consistency of our constructs, the Cronbach's α and composite reliability values ranged from 0.684 to 0.890 and from 0.803 to 0.893, respectively, indicating an adequate level of internal consistency.

Finally, following the guidance of Marsh and Dennis (1985), we computed the target coefficient (T) that was a ratio of the χ^2 value of the first-order model to the χ^2 value of the second-order model. The T coefficient was 0.93, indicating that the second-order factor explained the majority of relationships between the first-order factors (i.e. environmental performance, social performance and economic performance). All of the second-order factor loadings were significant, providing further evidence that the second-order factor model was appropriate.

4. Results

4.1 Structural model results

We examined the proposed relationship between the constructs by using structural equation modeling with the maximum likelihood estimation method. The model fit indices of the structural model are presented in Table I and indicate that it provided a good fit to the data based on the criteria of Schumacker and Lomax (2004) and Hu and Bentler (1999). The results of the standardized path coefficients for each hypothesized causal relationship are provided in Figure 1.

H1a and *H1b* predicted the positive effects of supplier integration on intra- and inter-organizational SMPs. In the structural equation model the paths between both relationships were positive and significant (path coefficient = 0.447, p-value < 0.001 for *H1a*; path coefficient = 0.582, p-value < 0.001 for *H1b*), providing strong support for *H1a* and *H1b*. *H2a* and *H2b*, which predicted the positive effects of customer integration on intra- and inter-organizational SMPs, were also supported (path coefficient = 0.110, p-value < 0.05 for *H2a*; path coefficient = 0.147, p-value < 0.01 for *H2b*). *H3a* and *H3b* predicted the positive effects of internal integration on intra- and inter-organizational SMPs. The results show that the relationship between internal integration and intra-organizational SMPs was positive and significant (path coefficient = 0.150, p-value < 0.001), whereas no statistically significant relationship was found between internal integration and inter-organizational SMPs, supporting *H3a* but not *H3b*.

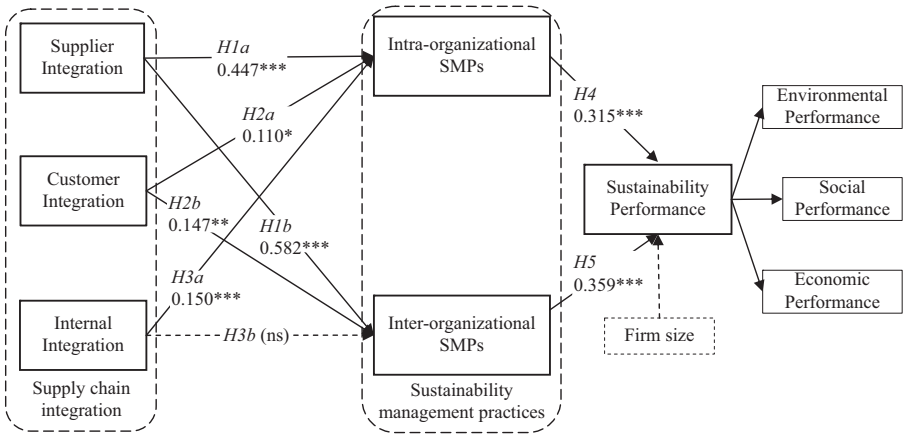

Figure 1.
Conceptual and structural equation models

Notes: The dashed lines indicate non-significant paths. *p<0.05; **p<0.01; ***p<0.001

We examined differences in the strength of associations between SCI and SMPs. A relative effect analysis was conducted by comparing the χ^2 difference between the constrained and unconstrained models. The results show that supplier integration had a significantly stronger effect on intra-organizational SMPs than both customer integration ($\Delta\chi = 20.72$, $\Delta df = 1$) and internal integration ($\Delta\chi = 44.18$, $\Delta df = 1$) and further confirm that the effect of supplier integration on the inter-organizational SMPs was significantly higher than customer integration ($\Delta\chi = 11.23$, $\Delta df = 1$).

H4 and *H5* predicted that both intra- and inter-organizational SMPs would be positively associated with sustainability performance. In the structural equation model, the paths between both relationships were positive and significant (path coefficient = 0.315, p-value < 0.001 for *H4*; path coefficient = 0.359, p-value < 0.001 for *H5*), providing strong support for *H4* and *H5*.

4.2 Additional analyses

To further understand the relationships between SMPs and sustainability performance, we tested the individual effects of SMPs on each dimension of sustainability performance (environmental, social and economic). Table III shows that there were significant direct relationships between both intra- and inter-organizational SMPs and environmental performance. Additionally, significant direction relationships were found between both intra- and inter-organizational SMPs and social performance. However, when it came to economic performance, only the coefficient for inter-organizational SMPs was statistically significant, indicating that intra-organizational SMPs were not directly related to economic performance. Using hierarchical regression analysis, we then tested the interaction effects of intra-organizational SMPs and inter-organizational SMPs on all three dimensions of sustainability performance. As shown in Table III, the results reveal that the interaction terms of intra-organizational SMSs and inter-organizational SMPs were significantly correlated with environmental performance (path coefficient = 0.038, p-value < 0.05) and social performance (path coefficient = 0.082, p-value < 0.001), but not with economic performance (path coefficient = 0.016, p-value > 0.1). These results indicate that both intra-organizational SMSs and inter-organizational SMPs acted as complements to jointly enhance environmental and social performance.

5. Discussion and implications

5.1 Theoretical implications

This study contributes to the sustainability management literature by expanding on the role and effective use of SCI in intra- and inter-organizational SMPs to achieve desired

	Environmental performance		Social performance		Economic performance	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	2.646	2.605	2.570	2.482	2.701	2.684
Firm size	−0.007	−0.006	−0.020	−0.019	−0.002	−0.002
Intra-organizational SMPs	0.081**	0.092**	0.182***	0.206***	0.038	0.043****
Inter-organizational SMPs	0.112***	0.104***	0.127***	0.109***	0.093***	0.089***
Intra-organizational SMPs × Inter-organizational SMPs		0.038*		0.082***		0.016
R^2	0.084	0.089	0.170	0.188	0.046	0.047
Adjusted R^2	0.081	0.085	0.168	0.184	0.043	0.043
F	28.40***	22.51***	63.45***	53.43***	15.04***	11.48***

Notes: $n = 931$. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p < 0.1$

Table III. Hierarchical regression analyses

sustainability performance. Most studies have emphasized external pressure (e.g. stakeholder and institutional) as the motivation underpinning sustainability management (Sancha *et al.*, 2015; Tate *et al.*, 2010; Wolf, 2014; Zhu *et al.*, 2013). Only some research has examined the impact of firm-specific resources and capabilities on SMPs and performance, and these have considered supply management capabilities (Bowen *et al.*, 2001) and strategic purchasing (Paulraj, 2011). By incorporating SCI into sustainability management and investigating the three dimensions of SCI as enablers of SMPs, this study provides a new perspective on how firms successfully implement SMPs to enhance sustainability performance.

Our empirical results suggest that external SCI (i.e. supplier and customer integration) and internal integration play a very important role in facilitating intra-organizational SMPs (*H1a*, *H2a* and *H3a*). Furthermore, they demonstrate that the successful implementation of intra-organizational SMPs generates external and internal SCI. Research has reported that SMPs are facilitated by both internal enablers (e.g. top management support, availability of resources, strategic purchasing and supply chain management capabilities) and external enablers (e.g. trust relationship with supply chain partners, logistical and technological integration) (Bowen *et al.*, 2001; Large *et al.*, 2013; Vachon and Klassen, 2006; Wilding *et al.*, 2012). Our results similarly offer strong empirical evidence that the internal integration of function and external integration with suppliers and customers is an important internal and external enabler for intra-organizational SMPs.

In addition, the results show that external SCI (i.e. supplier and customer integration) has a positive impact on inter-organizational SMPs (*H1b* and *H2b*). In contrast to external SCI, in this study internal integration was not significantly associated with inter-organizational SMPs. This complements the work of Bowen *et al.* (2001), who found that supply management capabilities did not significantly influence the greening of the supply process, which was part of inter-organizational SMPs. In their research, the concept of supply management capabilities included some supplier and internal integration capabilities. In line with these findings, we found that the capability of internal integration between functions did not significantly influence inter-organizational SMPs. However, contrary to Bowen *et al.* (2001), we found that supplier integration was an important supply management capability that played a role in facilitating inter-organizational SMPs. Our results are also similar to Vachon and Klassen (2006), who emphasized that technological integration (defined as information and knowledge sharing with suppliers and customers taking place in strategic areas) was positively linked to environmental monitoring and collaboration activities with external supply chain partners. Taking the findings of the previous studies and our findings together, it is evident that external supplier and customer integration are important enablers in inter-organizational SMPs. In other words, successful inter-organizational SMPs require well-designed and implemented external SCI, but they do not rely on internal integration.

In addition to the foregoing, our findings indicate that supplier integration has a stronger positive impact on both intra- and inter-organizational SMPs than do customer and internal integration. This suggests that supplier integration with the three types of SCI is the most important enabler of SMPs. Undoubtedly, pressure from the customer side is a major driver of SMPs, as a number of studies have emphasized (Gualandris and Kalchschmidt, 2014; Sancha *et al.*, 2015; Tate *et al.*, 2010; Zhu *et al.*, 2013). Customer requirements for sustainability are the key starting point for firms' SMPs efforts and drive firms to adopt sustainability-oriented strategies. However, they may be less helpful in putting sustainability-oriented strategies into daily practice than supplier integration. Contrary to the customers' driving role in SMPs, suppliers may be less likely to relate to a firm's sustainability-oriented strategies, but may nevertheless play a very important role in implementing SMPs. Studies have emphasized the importance of supply management and close cooperation with key suppliers when implementing SMPs (Bowen *et al.*, 2001; Wilding *et al.*, 2012), indicating the need for supplier

integration. Similarly, our findings highlight the positive role of supplier integration in implementing SMPs, which we argue is greater than customer and internal integration.

Finally, the positive impact of both intra- and inter-organizational SMPs on sustainability performance (*H4* and *H5*) were supported in our analysis. In other words, consistent with the findings of previous studies (Gimenez, Sierra and Rodon, 2012; Paulraj, 2011; Wilding *et al.*, 2012), we found that both intra- and inter-organizational SMPs played a very important role in achieving the desired sustainability performance (i.e. economic, environmental and social performance). Furthermore, the interaction of intra- and inter-organizational SMPs was significantly associated with two sustainability performance measures: environmental and social performance. Such a positive interaction effect was not found for economic performance. In other words, both intra- and inter-organizational SMPs functioned as complements to jointly enhance environmental and social performance.

5.2 Managerial implications

Because poor SMPs can lead to disappointing sustainability performance, it is important to ensure that there are adequate measures to effectively implement SMPs that achieve the desired overall sustainability performance. By focusing on the roles of SCI, our findings provide important implications regarding the successful implementation of SMPs.

First, manufacturers should understand the role of SCI in SMPs and build their SCI capabilities with internal and external supply chain partners. In this way, they can implement SMPs more effectively and efficiently to achieve their desired overall sustainability performance. Especially when firms operate their businesses under a high level of supply chain complexity, the relationship with supply chain partners can present collaboration and coordination difficulties (Bode and Wagner, 2015; Gimenez, van der Vaart and Pieter van Donk, 2012). In this situation, SMPs can become complicated and difficult to implement due to their connections with various supply chain partners. These challenges may be difficult to overcome unless manufacturers build up SCI capabilities that involve strategic collaboration, information sharing, joint decision making and system coupling with supply chain partners. Given the increasingly high complexity of supply chains in the current business environment, well-designed and implemented SCI can facilitate information flow and close collaboration between supply chain partners, enabling manufacturers to successfully implement SMPs.

Second, intra- and inter-organizational SMPs require different types of SCI. Specifically, manufacturers need to build up all three types of SCI to effectively implement intra-organizational SMPS. Alternatively, only the external SCI of suppliers and customers is necessary for inter-organizational SMPs. Considering that different types of SCI generate different effects on SMPs, manufacturers must clarify and classify the three types of SCI (i.e. supplier, customer and internal integration) to align the appropriate type of SCI with better implementation of intra- and inter-organizational SMPs.

Third, manufacturers must implement not only intra-organizational SMPs, but also inter-organizational SMPs to achieve their desired environmental, social and economic performance. If they focus only on intra-organizational SMPs without considering their external suppliers' sustainable practices, their sustainability performance may be limited and vulnerable. The failures of external suppliers' SMPs may lead to disappointing sustainability performance outputs. Specifically, when considering the positive interaction effects of intra- and inter-organizational SMPs on environmental and social performance, manufacturers must effectively combine the synergistic and complementary features of both SMPs. In other words, to achieve superior environmental and social performance, it is important that manufacturers ensure the simultaneous implementation of both intra- and inter-organizational SMPs.

6. Conclusions, limitations and future research

With the growing importance of collaborating with supply chain partners to implement sustainability, this study contributes to the literature by providing new perspectives on the important enablers of SMPs and valuable insights into the effective ways to use SCI in the sustainability management context. In this study, supplier and customer integration were enablers for both intra- and inter-organizational SMPs, whereas internal integration only enhanced intra-organizational SMPs. Intra- and inter-organizational SMPs were not only positively related to all three aspects of sustainability performance (i.e. economic, environmental and social performances), but also functioned complementarily to jointly promote both environmental and social performance. With that in mind, some limitations and issues must be further investigated.

First, although we explored the relationship between SCI and SMPs, future empirical investigations are needed to further examine this relationship. For example, the effects of SCI on SMPs may be influenced by various contingency factors. To understand the effectiveness of SCI in implementing SMPs, it would be interesting to explore the roles of these factors in the relationship between SCI and SMPs, for example, supply chain complexity (i.e. supplier complexity, customer complexity and internal complexity), product-level complexity and variety and environmental uncertainties (e.g. demand, supply and technological uncertainties).

Second, further investigation of the relationship between internal integration and inter-organizational SMPs is merited. Although our results show an insignificant relationship between internal integration and inter-organizational SMPs, we do not necessarily confirm that internal integration is useless to inter-organizational SMPs. As mentioned above, the consideration of contingency factors may help to uncover the conditions under which internal integration is useful to implementing inter-organizational SMPs.

Third, the inter-organizational SMPs in our study referred only to SMPs with suppliers. Studies have also considered sustainable supply management in the context of inter-organizational SMPs (Gualandris and Kalchschmidt, 2014; Paulraj, 2011; Wilding *et al.*, 2012). However, it may be more ideal to include key customers in inter-organizational SMPs, thereby providing greater insight into understanding the enablers of SMPs.

Finally, this study explored the relationships between SCI and SMPs without considering the differential effects of countries. Future studies may want to examine how these relationships differ from country to country (e.g. Europe vs non-Europe and developed vs developing countries). This would enrich the findings of this study.

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Appendix. List of survey items

Indicate the current level of implementation of, and action programs related to (1 – none; 5 – high).

Supplier integration:

(1) Sharing information with key suppliers (about sales forecasts, production plans, order tracking and tracing, delivery status, stock levels).

(2) Developing collaborative approaches with key suppliers (e.g. supplier development, risk/revenue sharing, long-term agreements).

(3) Joint decision making with key suppliers (about product design/modifications, process design/modifications, quality improvement and cost controls).

(4) System coupling with key suppliers (e.g. vendor managed inventory, just-in-time, Kanban, continuous replenishment).

Customer integration:

(1) Sharing information with key customers (about sales forecasts, production plans, order tracking and tracing, delivery status, stock levels).

(2) Developing collaborative approaches with key customers (e.g. risk/revenue sharing, long-term agreements).

(3) System coupling with key customers (e.g. vendor managed inventory, just-in-time, Kanban, continuous replenishment).

(4) Joint decision making with key customers (about product design/modifications, process design/modifications, quality improvements and cost controls).

Internal integration:

(1) Sharing information with purchasing departments (about sales forecasts, production plans, production progress and stock levels).

(2) Joint decision making with purchasing departments (about sales forecasts, production plans and stock levels).

(3) Sharing information with sales departments (about sales forecasts, production plans, production progress and stock levels).

(4) Joint decision making with sales departments (about sales forecasts, production plans and stock levels).

Intra-organizational SMPs:

(1) Energy and water consumption reduction programs.

(2) Pollution emission reduction and waste recycling programs.

(3) Formal occupational health and safety management systems.

Inter-organizational SMPs:

(1) Suppliers' sustainability performance assessment through formal evaluations, monitoring and auditing, using established guidelines and procedures.

(2) Training/education in sustainability issues for the suppliers' personnel.

(3) Joint efforts with suppliers to improve their sustainability performance.

How does your current performance compare with that of your main competitors? (1 – much lower; 5 – much higher).

Environmental performance:

(1) Materials, water and/or energy consumption.

(2) Pollution emissions and waste production levels.

Social performance:

(1) Workers' motivation and satisfaction.

(2) Health and safety conditions.

Economic performance:

(1) Unit manufacturing cost.

(2) Ordering costs.

(3) Manufacturing lead time.

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