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SUPPLY CHAIN INTEGRATION PATTERNS AND OPERATIONAL PERFORMANCE: A PLANT LEVEL SURVEY BASED ANALYSIS

Abstract
Though most scholars recognize that supply chain integration (SCI) can contribute to improving operational performance, previous studies on the SCI-performance link showed mixed results and several questions on this issue remain still open. In line with a configurational perspective, this study investigates whether plants adopting multiple integration practices (i.e. full SCI adopters) perform better than plants implementing only some selected SCI practices (i.e. partial adopters) and plants which do not implement any SCI practice (i.e. non-adopters). In addition, it analyzes whether partial adopters show a superior performance compared to non-adopters. Analyses based on a sample of 317 manufacturing plants reveal that full adopters perform better than non-adopters, in terms of quality, delivery, flexibility and efficiency. Among partial adopters, a particular SCI pattern, characterized by a high level of internal integration and supply chain planning, differs from non-adopters in terms of delivery, and shows results similar to full adopters in terms of quality and efficiency. More surprisingly, the other patterns of partial adopters do not significantly differ from non-adopters in any performance dimensions, and underperform full adopters in each performance. This suggests that in order to maximize SCI benefits companies should lever on multiple integration practices, and that in some cases focusing only on selected integration activities can be useless. A further interesting implication is that companies can cumulatively increase their operational performance towards a full exploitation of SCI benefits by following a certain sequence of SCI practices.

Keywords: Integration, Supply Chain Management, High Performance Manufacturing

1. Introduction

In recent years, the issue of supply chain integration (SCI) has been receiving an increasing attention from practitioners and academics (Childerhouse and Towill 2011, Danese and Romano 2012, Gimenez *et al.* 2012, van der Vaart *et al.* 2012). In several industries the internationalization of supply networks and fierce competition have led companies to set out programs in order to improve customers' satisfaction and efficiency through the integration of business processes along the supply network. Thus, from a managerial point of view, it is important to understand how successfully implementing SCI and what pitfalls should be avoided in order to maximize SCI benefits. At the same time, SCI represents for researchers a fascinating research area. In fact, although authors generally agree that companies can improve their performance through SCI, some recent literature reviews on the link between SCI and performance reveal that several questions on this issue remain still open (Fabbe-Costes and Jahre 2007, van der Vaart and van Donk 2008, Sofyalioglu and Öztürk 2012).

In particular, previous survey-based studies investigating the SCI-performance link showed mixed results (see Van der Vaart and van Donk 2008). One widely-acknowledged reason for the non-

unanimous findings on the SCI impact is that SCI operationalization varies significantly across studies. First of all, integration practices considered differ. Over the years, SCI has been studied from different angles (see Giannakis and Croom 2004), by focusing on such various integration practices as information processing (Lee *et al*. 1997, Lee *et al*. 2000, Zhao *et al*. 2002), production, inventory planning and logistics (Chandra and Fisher 1994, Ganeshan *et al*. 2001, Disney and Towill 2002, Romano 2009), buyer-supplier relationships (Carter *et al*. 2000, Fynes *et al*. 2005, Ciravegna *et al.* 2013), involvement in new product/process development and joint quality improvement programs (Carr and Pearson 2002, Petersen *et al*. 2003, Corsten and Felde 2005, Bandera *et al*. 2010, Jayaram and Pathak 2013). Previous studies differ also for the portion of the supply network examined since some authors concentrated their analysis to integration with suppliers (Scannell *et al*. 2000, Humphreys *et al*. 2004, Corsten and Felde 2005, Das *et al*. 2006, Bennett and Klug 2012), or customers only (Closs and Savitskie 2003, Fynes *et al*. 2005, Sahin and Robinson 2005). Others instead took a broader perspective by considering integration within companies' boundaries (i.e. internal integration) and with external partners, both customers and suppliers (i.e. external integration) (Narasimhan and Kim 2002, Kim 2006, Lee *et al*. 2007, Huo 2012, Liu *et al.* 2012, Turkulainen and Ketokivi 2012, Foerstl *et al.* 2013). Some few authors even recognized the importance of a broader span of integration (i.e. beyond the immediate network) (Kannan and Tan 2010).
However, a recent and even more notable research stream in SCM recommends adopting a configurational approach when studying the link between SCI and performance (McKone-Sweet and Lee 2009, Flynn *et al*. 2010, Danese 2013). This means that it is fundamental to consider the systemic nature of integration practices, as they are complementary and exert a synergic effect on companies' performance. According to this view, in order to maximize SCI benefits companies should lever on multiple integration practices and integrate processes along the whole supply network, within and outside companies' boundaries. Although authors agree on the need to lever simultaneously on different integration practices, empirical research investigating and measuring SCI as a multi-dimensional concept remain scarce (see Flynn *et al*. 2010).
In addition, several studies based on a configurational perspective of SCI focused on the analysis of moderating effects and synergies between some integration practices, assuming that the impact of a certain practice depends on the implementation of other practices which can hinder or amplify its effect on performance (Droge *et al*. 2004, Germain and Karthik 2006, Devaraj *et al*. 2007, Flynn *et al*. 2010). Although these studies contribute to advance theory on synergies in SCI, this approach is somewhat limited (Das *et al*. 2006, Flynn *et al*. 2010). In fact, reductionism and bounded rationality deter a full comprehension of interaction effects in SCI, which is a very complex phenomenon. For this reason, some authors preferred studying SCI as a set of interrelated integration activities, by establishing patterns or profiles of SCI. Frohlich and Westbrook (2001) developed the well-known taxonomy of 'arcs' of integration, based on customer and supplier integration. More recently, Flynn *et al*. (2010) provided a taxonomy based on the extent to which a company pays equal attention to internal, customer and supplier integration, and the extent to which SCI activities are carried out. Moreover, McKone-Sweet and Lee (2009) classified supply chain strategies on the basis of supply chain capabilities (coordination, planning, customer and supplier involvement) and Information Technology (IT) capabilities.
In line with these studies, this research intends to further analyze the link between different SCI patterns and performance. More precisely, this study groups integration practices into four bundles, i.e., internal integration, supply chain planning, customer involvement and supplier involvement

(see section 2.1). Based on these, it identifies three *a-priori* groups of plants: full, partial and non-adopters. Full adopters are those plants which extensively implement the four bundles of SCI practices, whereas non-adopters do not lever on any of these. Partial adopters are those plants which extensively lever on one, two or three of these classes of practices. The aim of this study is investigating, according to a configurational perspective, whether full SCI adopters perform better than partial adopters and non-adopters. In addition, we aim to examine whether partial adopters perform better than non-adopters. It is evident that even though partial adopters have in common the fact that they do not invest in all the practices, they represent a wide and heterogeneous group of plants in terms of SCI, and thus comparing the performance of this group of plants can be difficult. For this reason, to avoid potential biases when comparing full, partial and non-adopters, we ran also some additional analyses in order to better characterize partial adopters and make us confident that the results found about differences in performance are rigorous (see section 3.4). In line with other studies (Swink *et al*. 2007, McKone-Sweet and Lee 2009), this research adopts a plant level perspective, i.e., it analyzes the level of integration of a plant and its performance. In particular, we preferred focusing on plant operational performance in terms of product quality, delivery, flexibility and efficiency, rather than investigating plant business performance which can be subject to spurious effects.

We think that this perspective of study is particularly interesting and can contribute to advance the research stream on SCI patterns and performance for different reasons. First of all, our study differs from Frohlich and Westbrook (2001) and Flynn *et al*. (2010) in the SCI measures used and the level of analysis. It not only considers integration between functions, with customers and suppliers, but also within the supply chains which the focal plants operate in, thus going beyond a dyadic perspective. In addition, it analyzes SCI from a plant (not from a company/corporation) level, and this different view can help to advance and complement previous studies on the link between SCI patterns and performance (see section 2.1). The present study differs from Flynn *et al.* (2010) also because it doesn't consider operational performance as a unique construct, but it distinguishes between quality, delivery, flexibility and efficiency, thus more precisely investigating differences between SCI groups for each performance dimension. Finally, compared to previous studies on taxonomies (e.g. McKone-Sweet and Lee 2009, Flynn *et al.* 2010) which define SCI groups '*a posteriori*' and hypothesize simply that they are related to performance, this research defines three *a-priori* clusters: full, partial and non-adopters, and is very precise in hypothesizing how they can differ in terms of performance, according to a configurational perspective. We believe that the choice of examining and comparing these three *a-priori* groups can represent an original point of view to studying SCI, as it allows to address some unanswered questions on the successful implementation of SCI. Although the configurational perspective would suggest addressing all the SCI practices above mentioned in order to maximize performance, previous studies do not examine in detail whether a partial implementation of SCI (e.g. by focusing on a narrower set of integration practices) could guarantee a better performance anyway or whether any benefit is hindered given the absence of potential synergies between integration practices. We cannot ignore that companies often have limited resources and the roadmap towards a complete SCI implementation requires to implement different selected practices over time. Thus, it is crucial for companies to understand whether they should expect significant benefits since the beginning of a SCI program, or in order to achieve the targeted results a long-term perspective is needed.

The paper is organized as follows. First, it analyzes literature on SCI and discussed the research hypotheses. The following section introduces the sample, measures, data collection and results found. This is followed by a discussion about the theoretical and managerial implications of this study. Finally, conclusions report some suggestions for future research.

2. Literature Review

2.1 SCI practices

As pointed out in the introduction section, previous studies used different measures of SCI (Table 1). Narasimhan and Kim's (2002) operationalization of SCI is widely cited. Based on this study, several recent works divide SCI into three dimensions: internal, customer and supplier integration (Kim 2006, Flynn *et al*. 2010, Zhao *et al.* 2011, Huo 2012). Customer and supplier integration refer to the degree to which a manufacturer partners with customers/suppliers to structure inter-organizational strategies, practices and processes into collaborative synchronized processes, while internal integration focuses on activities within a manufacturer (Flynn *et al*. 2010). Compared to Narasimhan and Kim (2002), some studies (e.g. Flynn *et al*. 2010, Zhao *et al.* 2011, Huo 2012) extend the customer and supplier integration constructs by adding a set of items about information sharing with major customers and suppliers for plan coordination. In line with these studies, Zailani and Rajagopal (2005) categorized SCI dimensions into four major groups: information sharing, internal integration, integration with customers and suppliers.

However, in the literature we can find very different classifications of SCI dimensions (e.g. Swink *et al.* 2007, van der Vaart and van Donk 2008, McKone-Sweet and Lee 2009, Leuschner *et al.* 2013). Even though a convergence still lacks, authors agree that considering the operational and strategic/relational nature of SCI is fundamental, and the mix of items used reflects this basic assumption (see Table 1). Operational activities mainly concern the coordination of flows and processes upstream and downstream, while firms involved in strategic integration relationships view their partners as extensions of their own and thus strategic integration activities include relationship building, joint development activities, and working closely to solve problems (Swink *et al.* 2007, Flynn *et al*. 2010). Leuschner *et al*.'s (2013) meta-analysis of SCI confirms the importance of taking into account both perspectives. They identified three SCI dimensions: information, operational and relational integration. The first two refer to operational integration activities, while relational integration is linked to the strategic nature of SCI.

Based on literature on SCI, this research includes four SCI dimensions: customer and supplier involvement, supply chain planning and internal integration. The intention was to cover the basic concepts usually used to measure SCI, both operational and strategic. As concerns customer and supplier involvement and supply chain planning, we used the same scales validated by McKone-Sweet and Lee (2009). Customer involvement considers some basic concepts included in several other scales, such as close contacts with customers (Narasimhan and Kim 2002, Kim 2006, Swink *et al*. 2007, Flynn *et al*. 2010), interactions with customers to get feedbacks and understand their needs (Narasimhan and Kim 2002, Kim 2006, Swink *et al.* 2007, Flynn *et al.* 2010), manufacturer's engagement and active participation by customers in order to increase customer satisfaction (Swink *et al*. 2007). In line with Zailani and Rajagopal's (2002) definition of supplier involvement (see Table 1), this dimension includes such concepts as working closely with suppliers to solve problems and find effective solutions, and a positive attitude towards collaboration and openness of communication. Supply chain planning refers to the importance of using a supply chain perspective in planning activities, and captures the need for integrated planning that incorporates information from customers and suppliers (McKone-Sweet and Lee 2009). On the one hand, the value and benefits of supply chain planning are confirmed by a number of researchers who mathematically studied optimal integrated planning solutions (Cohen and Lee 1988, Martin *et al.* 1993, Chandra and Fisher 1994, Cheng and Wang 1997, Fumero 1999, Park 2005, Feng 2008, Feng 2010, Fahimnia *et al.* 2013). On the other hand, as you can note from Table 1, this concept is common to many SCI studies. However, differently from Narasimhan and Kim (2002) or Flynn *et al*. (2010), by explicitly measuring the integration of plans in the plant's supply chains, this dimension allows to go beyond a dyadic perspective when studying SCI. Finally, a further concept considered is internal integration, i.e. integration between functions within the plant. In line with SCI studies cited in Table 1, this dimension does not focus on the dyadic integration between logistics and other functional areas – as several other studies on SCI do (e.g. Chen *et al*. 2007) - but intends to examine whether in general functions are integrated and work together in order to solve conflicts in a cooperative manner. The internal integration scale adopted in this study was used in the Rounds 1 and 2 of the High Performance Manufacturing research project (Schroeder and Flynn 2001, pp. 11) (see section 3). By adopting these SCI measures, this study aims to capture both the operational and strategic/relational nature of SCI. In fact, it includes operational integration activities - e.g., planning and monitoring supply chain activities and customer's involvement in product design process - and strategic integration activities, e.g., working closely to solve problems and collaborative relationships.

Table 1. Some previous studies on SCI

Studies	SCI dimensions	Operationalization/definitions	Level of analysis
Narasimhan and Kim (2002)	Internal integration Integration with customers Integration with suppliers	*Internal integration*: Data integration among internal functions through information network, system-wide information system integration among internal functions, real-time searching of the level of inventory, real-time searching of logistics-related operating data, data integration in production process, integrative inventory management, the construction of system-wide interaction system between production and sales, the utilization of periodic interdepartmental meetings among internal functions *Integration with customers*: Follow-up with customers for feedback, the level of computerization for customer ordering, the level of organic linkage with customers through information network, the level of sharing on market information, the agility of ordering process, the frequency of periodical contacts with customers, the level of communication with customers *Integration with suppliers*: Information exchange with suppliers through information technology, the level of strategic partnership with suppliers, the participation level of suppliers in the design stage, the participation level of suppliers in the process of procurement and production, the establishment of quick ordering system, stable procurement through network	Manufacturing corporations
Vickery et al. (2003)	Integrative information technologies Supply chain integration	*Integrative information technologies* : Integrated electronic data interchange, integrated information systems, computerized production systems *Supply chain integration*: Supplier partnering, closer customer relationships, cross-functional teams	Firm level
Zailani and Rajagopal (2005)	Information sharing Internal integration External integration with suppliers External integration with customers	(SCI dimensions not explicitly articulated) *Information sharing*: Refers to exchange of information among company, customers and suppliers *Internal integration*: Integration among internal functions *External integration with suppliers*: Company working closely with suppliers, viewing this latter as an important component of the supply chain, how closely suppliers work with company to seal	Not applied

		a deal and level of strategic partnership *External integration with customers*: Company working closely with customers, viewing this latter as an important component of the supply chain, and follow-up with customers for feedback	
Kim (2006)	Company's integration with suppliers Cross functional integration within a company Company's integration with customers	Narasimhan and Kim's (2002) operationalization	Manufacturing corporations
Swink et al. (2007)	Strategic Customer integration Strategic Supplier integration Product–process technology integration Corporate strategy integration.	*Strategic customer integration*: Close contacts with customers, results of customer satisfaction surveys shared with all employees, opportunities for employee–customer interaction, a formal customer-satisfaction program *Strategic supplier integration*: Cost information sharing, joint cost/quality improvement, real time production schedule information with suppliers, early supplier involvement in product design, buyer–supplier councils *Product-process technology integration*: New ways to coordinate design/manufacturing issues, design-for-manufacture/assembly (DFMA) methods , manufacturing involvement and sign-off for new products , job rotation between design and manufacturing engineering, use of manufacturability guideline by product designers, equal status of product designers and manufacturing staff have in NPD projects *Corporate strategy integration*: Manufacturing strategy aligned with corporate strategy , clear definition of strategic manufacturing goals and objectives , strategy based on existing capabilities, manufacturing decisions driven by corporate strategy, manufacturing strategies and goals communicated to all employees , frequent revision of manufacturing strategy	Manufacturing plant level
Van der Vaart and van donk (2008)	Practices Attitudes Patterns	(SCI dimensions not explicitly articulated) *Practices*: Tangible activities or technologies (e.g., Electronic Data Interchange, Vendor Managed Inventory, etc.) *Attitudes:* Attitude of buyers and suppliers towards each other or towards SCM. *Patterns*: E.g., regular visits to supplier's facilities, face-to-face communication, etc	Not applied
McKone-Sweet and Lee (2009)	Coordination Planning Supplier Involvement Customer Involvement Exploitation (Internet) Exploration (Internet)	*Coordination*: Purchasing of common materials coordinated at the corporate level, corporate ordering and stock management policies, aggregate planning for plants according to global distribution needs, managerial innovations transferred among plants technological innovations and know-how transferred between plants *Planning*: Planning of supply chain activities, customers' forecasts considered in supply chain planning, supply chains managed as a whole, performance of members of supply chains monitored in order to adjust supply chain plans, indicators of supply chain performance *Supplier involvement*: Sharing problems with suppliers, willingness to change assumptions in order to find more effective solutions with suppliers, positive attitude toward cooperating with suppliers, openness of communications in collaborating with suppliers *Customer involvement*: Close contact with customers, customers' feedback on quality and delivery performance, customer involvement in product design process, responsiveness to customers' needs, regularly survey of customers' needs *Exploitation*: Use of Internet for supporting different activities (e.g. transmitting orders to suppliers, tracking/tracing supply orders, etc.) *Exploration*: Use of Internet for supporting different activities (e.g.	Plant level

		scanning the marketplace for identification of potential sources, receiving and comparing suppliers' offers, etc.)	
Flynn et al. (2010)		*Internal Integration*: Data integration among internal functions, enterprise application integration among internal functions, integrative inventory management, real-time searching of the level of inventory, real-time searching of logistics-related operating data, the utilization of periodic interdepartmental meetings among internal functions, the use of cross functional teams in process improvement, the use of cross functional teams in new product development, real-time integration and connection among all internal functions from raw material management through production, shipping, and sales *Customer Integration*: Narasimhan and Kim's (2002) items and, in addition, sharing of point of sales (POS) information, customers' demand forecast, manufacturer's available inventory and production plans *Supplier Integration*: Narasimhan and Kim's (2002) items and, in addition, sharing of suppliers' production schedule, production capacity and available inventory, and of manufacturer's production plan, demand forecast and inventory level, joint suppliers' process improvements.	Manufacturing companies
Huo (2012)	Internal integration Customer Integration Supplier Integration	Internal Integration: Flynn et al.'s (2010) operationalization Customer Integration: Flynn et al.'s (2010) operationalization Supplier Integration: Flynn et al.'s (2010) operationalization	Manufacturing companies
Leuschner et al. (2013)	Information integration Operational integration Relational integration	(SCI dimensions not explicitly articulated) *Information integration*: Refers to the coordination of information transfer and collaborative communication in the supply chain *Operational integration*: Refers to the collaborative joint activities, and coordinated decisions making in the supply chain *Relational integration*: Refers to the adoption of a strategic connection between firms in the supply chain	Not applied

A further difference between SCI studies consists in the level of analysis adopted, i.e. manufacturing corporations vs. manufacturing plant level. In line with some previous survey-based studies (Swink *et al*. 2007, McKone-Sweet and Lee 2009), we adopted a plant level perspective. On the one hand, this choice may help to reduce potential response bias as the object of analysis, i.e. the plant and its level of SCI, is 'concrete singular', meaning that it consists of one object that is easily and uniformly imagined (Bozarth *et al.* 2009). Differently, within a manufacturing corporation, the level of SCI could be inhomogeneous across the different plants and portions of the supply network, especially when the manufacturing corporation includes many plants with different roles and maturity levels, and this can determine biased responses on SCI or the level of company performance. On the other hand, the plant perspective adopted in this study also has limitations. For instance, studying integration at a corporate level allows to involve respondents which usually have a more complete understanding of the company SCI strategy. Instead, by adopting a plant level perspective, the risk is collecting responses by not informed respondents, which could not reflect the real situation of SCI. For this reason, in this research, we adopted several countermeasures to reduce this risk. Firstly, we selected largely independent plants playing an active role in their corporations (Danese and Filippini 2010). Moreover, we identified as respondents key plant informants and people considered the most knowledgeable about the topic of interest. Finally, we collected responses from multi-respondents within the same plant and compared them in order to assure consistency (see section 3).

2.2 The link between SCI and performance: Some theoretical lens

Literature in general agrees that SCI leads to a better performance for the focal organization and its supply network (Lee *et al*. 2007, Flynn *et al*. 2010, Liu *et al*. 2013). Over the years, authors have provided several interpretations of this phenomenon based on some primary theories (Hitt 2011). Numerous researchers used Transaction Cost Analysis (TCA) to shape arguments for a positive relationship between SCI and performance. TCA recognizes the role of SCI as a hybrid governance mechanism that helps companies to gain the same advantages of vertical integration, thanks to trust and familiarity among supply chain partners, especially in an uncertain environment (Carr and Pearson 1999, Larsen 1999, Das *et al*. 2006, Cao *et al.* 2010). Other studies investigated the relationship between SCI and performance according to a resource-based view or organizational capability perspective (Larsen 1999, Rungtusanatham *et al*. 2003, Das *et al*. 2006, Squire *et al*. 2009, Cao *et al.* 2010, Huo 2012). According to this view, working in close contact and sharing complementary knowledge with partners in the supply network breed unique and distinctive capabilities, which allow companies to achieve a long-term competitive advantage over their competitors. Linked to this, Swink *et al.* (2007) and Cao *et al*. (2010) mention the knowledge-based view (KBV) of the firm, based on the assumption that integration involves knowledge dissemination and sharing activities that create new knowledge, which in turn improves organizational capabilities. Organizational Information Processing Theory (Galbraith 1974) is a further theory that was used to interpret the positive effect of SCI (Swink *et al*. 2007). Integration of processes across the supply network based on information sharing and enrichment drastically reduces the uncertainty in planning, operational and logistics activities, by increasing companies' information processing capabilities. This in turn reduces inefficiencies (e.g. high stocks, or rush deliveries) while at the same time allows to increase flexibility and punctuality, to anticipate demand changes and new market/technological opportunities.

2.2.1 The configurational theory of SCI and research hypotheses

Although many researchers recognize the positive impact of SCI and interpret this positive link based on the theories above mentioned, it is worth noting that some studies do not show any impact, or show the opposite (Stank *et al.* 2001, Flynn *et al*. 2010, Danese and Romano 2013).

For instance, starting from information-processing theory and knowledge based view, Swink *et al.* (2007) hypothesized a positive relationship between integration – measured as supplier, customer, product-process technology and corporate integration – and cost, quality, delivery, process and new product flexibility. They found that, except for product-process technology integration, the other integration dimensions were not significantly associated with performance, while supplier integration was even associated with a poorer quality capability. Das *et al*. (2006) even theorize that an opposing dynamic of integration exists, and argue that supplier integration potentially creates inflexibility and impedes adaptation to uncertainty, which can determine unanticipated subsequent costs. Similarly, Swink *et al.* (2007) explain that too much supplier integration can foster negative effects due to opportunism and moral hazard. A further potential issue in integration which can determine abnormal behaviours is schedule nervousness, i.e. when a buyer frequently updates the supplier about its final demand, thus causing frequent changes in supplier's delivery and production plans (Ren 2003, Terwiesch *et al*. 2005). In fact, this can discourage the supplier to allocate in advance capacity to satisfy future buyer's requests.

This research draws upon configurational theory to address and interpret the link between SCI and performance and the dynamics of SCI. This theory is based on the assumption that in order to be successful, SCI should be necessarily viewed as a multi-dimensional concept simultaneously addressing several practices and involving several actors, within and outside companies' boundaries (Mckone-Sweet and Lee 2009, Barros *et al.* 2013, Danese 2013). The view that a significant performance improvement depends on a coherent mix of integration activities is not new. In their seminal article, Frohlich and Westbrook (2001) demonstrate that a myopic focus on a single type of integration activity (i.e. towards suppliers or customers only) may lead the manufacturing plant to underperform both in terms of productivity and profitability. In general, the importance of integrating all the activities and processes along the supply network can be found in numerous definitions of SCM (Ellram and Cooper 1993, Lummus and Alber 1997, Monzcka and Morgan 1997, Croom *et al*. 2000, Slack *et al*. 2004). More recently, Das *et al*. (2006) and Flynn *et al*. (2010) suggested that a configurational perspective can be helpful for interpreting the ambiguity of the link between SCI and performance. Flynn *et al.* (2010) applied a configurational approach to delve more deeply into how the dimensions of SCI work together, in order to learn about how various SCI patterns are related to performance. According to a configurational view, the implementation of single or a narrow set of SCI initiatives could not guarantee alone the achievement of significant advantages. Some studies explicitly demonstrate that a partial implementation of SCI can even compromise any benefit. For instance, some authors argued that a primary impediment to achieving the benefits of external SCI is intra-organizational barriers to internal integration. Droge *et al.* (2004) found that internal integration moderated the effect of external integration on performance; Germain and Karthik (2006) state that external integration alone, without internal integration, would limit the level of performance improvement. On the contrary, it is also well-known that internal integration alone is not sufficient to achieve significant benefits, if the company does not integrate upstream and downstream (Stevens 1989, Kim and Narasimhan 2002). Other authors extended these analyses by investigating potential synergies between supplier and customer integration or between customer, supplier and internal integration. Devaraj *et al*. (2007) found that customer integration moderated the relationship between supplier integration and performance. Flynn *et al*. (2010) studied the synergic effect of supplier, customer and internal integration on operational and business performance, and compared different types of SCI patterns. They found that a SCI configuration based on extensive use of all these three dimensions has the best operational and business performance; whereas companies which do not lever on any of these have the worst performance. Among these two extremes, many other patterns of SCI do not show any significant difference with not-integrated companies (except for those companies which extensively integrate downstream). All these studies support that in general, focusing only on a specific category of integration practices (internal, customer or supplier integration) can help to solve some specific problems, reduce inefficiencies and smooth certain activities and processes but, when inefficiencies persist in other processes, activities and supply network tiers, any benefit could be lost. Besides internal (or external) integration, several other synergies between integration practices are discussed in the literature. For instance, in line with Das *et al*. (2006) and Swink *et al*. (2007), based on a multiple-case study, Danese *et al*. (2006) demonstrate how the implementation of a certain SCM initiative can determine unexpected additional costs and difficulties, which requires implementing further integration initiatives. They argue also that the absence of a certain integration practice can hinder to achieve positive benefits through the implementation of another integration practice. For example, jointly planning supply chain activities require long-term cooperative contracts (Danese *et al.* 2006), or Vendor Managed Inventory (VMI) practices should be accompanied by adequate supply network performance measurement systems and collaborative relationships with customers/suppliers, in order to avoid opportunistic behaviours (Danese 2006).

Thus, consistently with these studies, we may suppose not only that full adopters (i.e. plants extensively adopting customer and supplier involvement, supply chain planning and internal integration) have a better performance compared to partial adopters (i.e. plants implementing only some selected SCI practices) and non-adopters (i.e. plants which do not implement any SCI practice), but also that partial adopters could not gain a significant advantage compared to non-adopters. In this way, the configurational theory could provide an interesting argument for interpreting the not unanimous findings on the SCI-performance link.

As regards full adopters, companies that choose to invest extensively in SCI by implementing different integration practices within and outside companies' boundaries can improve a wide range of performance dimensions, such as quality, costs, delivery and flexibility. In fact, exchanging information and working in close contact with external partners and internal functional areas allows to better direct quality improvement programs, identify potential quality problems in advance and exploit complementary knowledge in order to develop and test new ideas and solutions (Carter and Miller 1989, Chen *et al*. 2004, Bandera *et al*. 2010). As a consequence, SCI can lead to an improved product quality, both in terms of conformance to specifications and product capability/performance. In addition to this, integration is usually considered a powerful remedy to the so-called bullwhip effect linked to information distortions along the supply chain, that in turn generates inefficiencies (e.g. high stocks) or stock outs, and thus a poor delivery performance (Lee *et al*. 1997). Aligning and monitoring supply chain activities through supply chain planning, and working in close contact in order to solve exceptions and problems through customer/supplier involvement and internal integration allow to smooth materials flows along the supply chain, and prevent potential problems in the logistics process. Efficiency increases thanks to reduced stocks and inefficiencies (e.g. rush deliveries) (Hariharan and Zipkin 1995, Chen *et al.* 2000, Wangphanich 2010); while at the same time delivery performance improves because stock-outs lower, delivery plans becomes more accurate and any potential problems which could interrupt production processes are detected in advance (Stalk and Hout 1990). Finally, flexibility improves because integration among functions and with customers and suppliers allows the whole supply network to respond quickly to shifts in customers' demands (Ring and van de Ven 1994, Heide and Stum 1995, Suarez *et al.* 1995, Rosenzweig *et al*. 2003, Romano 2009).

As regards partial adopters, based on the configurational theory and the above mentioned studies (Danese *et al.* 2006, Das *et al*. 2006, Flynn *et al.* 2010), we could argue that they could not have a better performance compared to non-adopters. However, this view is in contrast with all those studies proving that also a partial implementation of SCI (e.g. focused on the downstream or upstream network) can contribute to improve operational performance anyway (Closs and Savitskie 2003, Humphreys *et al*. 2004, Corsten and Felde 2005, Fynes *et al*. 2005, Sahin and Robinson 2005). Nevertheless, research focused on the link between single SCI practices and performance (e.g. Scannell *et al*. 2000, Closs and Savitskie 2003, Humphreys *et al*. 2004, Fynes *et al*. 2005, Sahin and Robinson 2005) often does not control for the effect of the other SCI practices.

Based on the discussion above, we advance the following research hypotheses. Hypotheses 1 and 2 state the superiority, in terms of operational performance, of plants implementing all SCI practices (i.e. full adopters). In addition, we follow the approach of Naor *et al*. (2010), by suggesting two alternative hypotheses about the difference between partial adopters and non-adopters (Hypotheses 3a and 3b).

Hypothesis 1: Full adopters have a better efficiency, product quality, delivery and flexibility performance than non-adopters.
Hypothesis 2: Full adopters have a better efficiency, product quality, delivery and flexibility performance than partial adopters.
Hypothesis 3a: Partial adopters have a better efficiency, product quality, delivery and flexibility performance than non-adopters.
Hypothesis 3b: Partial adopters have not a better efficiency, product quality, delivery and flexibility performance than non-adopters.

3. Methods

3.1 Sample and data collection

This research is part of the High Performance Manufacturing (HPM) international project (Round 3) which involves several groups of researchers worldwide who have been in charge to gather data from manufacturing plants sited in Austria, China, Finland, Germany, Italy, Japan, Korea, Spain, Sweden and US. The surveyed plants, randomly selected from master lists published in each nation involved, were either traditional or high performers, had more than 100 employees and belonged to electronics, mechanical and transportation equipment industries. In case of plants part of multi-plant corporations, we verified that they were largely independent plants playing an active role in their corporations. Before sending the questionnaires, members of the research team called the CEOs to better explain the research project, verify firm's intention to participate in, and verify whether the plant performed internally the activities investigated by HPM survey (e.g., new product development, purchasing, distribution, production planning, process engineering etc.) and thus whether plant's respondents were able to fill all the 23 separate HPM questionnaires. In particular, we suggested potential respondents for each questionnaire (e.g., plant managers, inventory managers, plant superintendents, supervisors, process engineers etc.), but we asked also to identify the most informed person within the plant about a specific topic, to provide us with his/her name and contact address, in order to distribute to the respondents the questionnaires. In order to raise the reliability of measurement, respondents were requested to consult with others in the same department or functional executives as appropriate when answering questions. To reduce the risk of biased responses, we administered each questionnaire to different respondents in every plant. We verified that all the Interclass Correlation (ICC) indexes were above 0.70 to ensure that the inter-rater agreement in each plant was acceptable (Boyer and Verma, 2000). Finally, we averaged the responses gathered from the multiple respondents within each plant to obtain plant scores at a plant level.
The HPM questionnaires incorporated different type of items (e.g. objective items, perceptual scales, reverse coded items) with the aim of reducing the common methods variance. (For further details on plant selection, data collection and HPM questionnaires, see also Danese et al. 2013).
We collected data from 317 plants. As Tables 2 and 3 show, the stratification across the sectors is good.

Table 2. Demographics for sample plants (mean values per industry)

Sample characteristics	*Electronics*	*Machinery*	*Transportation*
Number of plants in the sample	109	104	104
Plant size (number of hourly and salaried personnel)	895	977	840
Percentage of sales exported (%)	51.17	49.28	41.92
Percentage of materials imported (%)	40.56	20.23	24.78

Table 3. Sample distribution according to sector and country

Country	Industry			Total plants
	Electronics	Machinery	Transportation	
Austria	10	7	4	*21*
China	21	16	14	*51*
Finland	14	6	10	*30*
Germany	9	13	19	*41*
Italy	10	10	7	*27*
Japan	10	12	13	*35*
South Korea	10	10	11	*31*
Spain	9	9	10	*28*
Sweden	7	10	7	*24*
United States	9	11	9	*29*
Total plants	*109*	*104*	*104*	*317*

3.2 Measures

Respondents for the items used in the present research were: plant managers, inventory managers, plant superintendents, supervisors, process engineers and quality managers.

The model developed includes eight multi-item constructs. According to literature (see section 2), we considered four classes of SCI practices: supply chain planning, customer involvement, supplier involvement and internal integration (Table 4). All the items comprising the four constructs were developed from Likert-scaled items, with values ranging from 1 ("strongly disagree") to 7 ("strongly agree"). Supply chain planning, supplier- and customer-involvement scales were previously validated and tested by Mckone-Sweet and Lee (2009). Supply chain planning measures the ability of planning and monitoring supply network activities, so to managing each of the supply chains as a whole. Customer involvement considers close contact relationships, feedback on quality and delivery performance, joint quality improvement efforts, and working together to satisfy customers' needs. Supplier involvement measures collaboration with suppliers in order to solve problems occurred, openness of communication and willingness to cooperate. Internal integration scale was taken by Rounds 1 and 2 of the High Performance Manufacturing research project (Schroeder and Flynn 2001, pp. 11). The scales included in the HPM project were developed by several coordinated research groups around the world and are based on existing literature. At the beginning of HPM project (first round), the content validity of each scale was checked through interviews with experts and managers. After data collection of each HPM round, the reliability and convergent validity of each scale was verified by HPM administrators (Schroeder and Flynn 2001).

As regards the items referring to the four operational performance dimensions considered (i.e., product quality, delivery, flexibility and efficiency), we asked respondents to provide their opinion about plant's performances compared with its competitors on a 5-point Likert scale (1 is for "poor, low" and 5 is for "superior") (Table 4).

Product-quality, delivery and flexibility scales were previously validated and tested by Naor *et al*. (2008) and Liu *et al*. (2009). Product quality performance refers to the levels of quality conformance and the capability and performance of the product. Delivery performance measures the ability of a firm to deliver fast and on-time, while flexibility regards the capability of a firm to adapt and change the product mix and volumes. Efficiency performance considers the unit cost of manufacturing and inventory turnover (McKone-Sweet and Lee 2009). In order to reduce potential biases when measuring operational performance, in line with other studies (e.g., Danese and Kalchschmidt 2011), we collected also some objective data of the plant performance and verified the existence of a significant correlation between perceptual measures and objective data which could be related. We found that the unit cost of manufacturing is correlated with manufacturing costs (in dollars), on-time delivery with the percentage of orders shipped on time, fast delivery with the average lead time (i.e., days from the receipt of an order until it is shipped), flexibility to change product mix and volume with total cycle time (i.e., days from receipt of raw materials until the product is received by customer).

Confirmatory Factor Analysis (CFA) was utilized to ensure the convergent validity, discriminant validity and reliability of our scales. We used LISREL 8.80 to analyze the measurement model. Convergent validity for multi-item constructs is demonstrated when all factor loadings of the observable variables on their latent construct are statistically significant and above the threshold limit of 0.50. We verified that all factor loadings are significant at 0.01 level and above 0.52 (factor loadings and t-values are reported in Table 4). The overall fit of the CFA was judged to be satisfactory (χ^2 = 472; d.f. = 271; χ^2/d.f. = 1.74; RMSEA = .0462 [.0388; .0536]; CFI = .970). Discriminant validity was checked by using the Chi-square test. For each pair of constructs, two nested models were compared. The first model was set with an unconstrained correlation between the two constructs, whereas in the second model the correlation was fixed to 1. If the difference between the two Chi-squares is significant, then we can conclude that the two constructs are distinct. In our analyses, all differences are significant (p-value < 0.01), thus ensuring discriminant validity. Finally, we assessed the reliability of each construct by using the composite reliability. Composite reliability values are all greater than 0.70, indicating high reliability.

To avoid the problem of reaching incorrect conclusions due to potential differences across countries, we verified that our SCI constructs have an adequate cross-national equivalence. Therefore, we assessed measurement invariance by dividing our data by country and performing configural, metric and scalar invariance tests (Steenkamp and Baumgartner 1998). For this test, since the sample size by country was smaller than the number of parameters, we tested two separate models, the first including supply chain planning and internal integration, and the second one, customer involvement and supplier involvement. Table 5 summarizes the results of the measurement invariance tests. Configural invariance was assured because the models fit data well and the factor loadings across different countries were significantly different from zero. Metric invariance tests whether the factor loadings are identical across groups. To perform this analysis we constrained the factor loadings to be the same across countries and we found that delta χ^2 tests were not statistically significant, thus ensuring that measurement items were interpreted by different respondents in an equivalent manner. Scalar invariance tests the consistency between differences in latent and observed means by constraining the intercepts to be the same. Also in this case we found that delta χ^2 tests were not statistically significant, and thus we can conclude that SCI constructs can be considered equivalent across countries (Steenkamp and Baumgartner 1998).

Table 4. Measurement scales and items

Construct	Item	Lambda[a]	*t*-value
Internal integration (II)	The functions in our plant are well integrated.	0.803	-
	Problems between functions are solved easily, in this plant.	0.802	14.689
	Functional coordination works well in our plant.	0.840	15.268
	Our business strategy is implemented without conflicts between functions.	0.615	10.928
Supply Chain Planning (SCP)	We actively plan supply chain activities.	0.719	-
	We consider our customers' forecasts in our supply chain planning.	0.577	9.396
	We strive to manage each of our supply chains as a whole.	0.661	11.142
	We monitor the performance of members of our supply chains, in order to adjust supply chain plans.	0.731	11.782
	We gather indicators of supply chain performance.	0.785	12.523
Supplier involvement (SI)	We are comfortable sharing problems with our suppliers.	0.803	-
	In dealing with our suppliers, we are willing to change assumptions, in order to find more effective solutions.	0.540	9.017
	We believe that cooperating with our suppliers is beneficial.	0.689	11.518
	We emphasize openness of communications in collaborating with our suppliers.	0.684	11.530
Customer involvement (CI)	We frequently are in close contact with our customers.	0.756	-
	Our customers give us feedback on our quality and delivery performance.	0.688	11.182
	Our customers are actively involved in our product design process.	0.560	9.143
	We strive to be highly responsive to our customers' needs.	0.727	11.765
	We regularly survey our customers' needs.	0.682	10.460
Product Quality (QUAL)	Quality conformance	0.803	-
	Product capability and performance	0.580	6.358
Delivery (DEL)	On time delivery performance	0.840	-
	Fast delivery	0.742	10.870
Flexibility (FLEX)	Flexibility to change product mix	0.660	-
	Flexibility to change volume	0.855	8.266
Efficiency (EFF)	Unit cost of manufacturing	0.528	-
	Inventory turnover	0.626	5.694

Note: [a] Completely standardized values

Table 5. Invariance test results

	χ^2 value	d.f.	CFI	RMSEA	$\Delta \chi^2$
supply chain planning and internal integration					
Configural invariance	357	260	0.943	0.062	-
Metric invariance	433	323	0.935	0.065	76
Scalar invariance	503	386	0.928	0.067	70
customer involvement and supplier involvement					
Configural invariance	369	260	0.937	0.064	-
Metric invariance	436	323	0.929	0.065	67
Scalar invariance	517	386	0.919	0.070	81

3.3 Results

The aim of this work is testing whether there are differences in the operational performance between plants that don't lever on any SCI practice (non-adopters), plants that adopt only some selected SCI practices (partial adopters) and plants that implement all the classes of SCI practices considered, i.e. supply chain planning, customer involvement, supplier involvement and internal integration (full adopters). To test our hypotheses, we divided the sample into three groups as follows. For each plant, we computed a score (i.e. the mean value of the scale) for each class of SCI practices abovementioned. After that, we calculated the median of each SCI scale (i.e. Internal Integration = 5.08; Supply Chain Practice = 5.23; Supplier Involvement = 5.54; Customer Involvement = 5.42) and for each class of practices we assigned a high- or low-implementation value to the plants above or below the median respectively. Finally, we formed three groups of plants. The first group is composed by plants with four 'low' scores (i.e. non-adopters), the second group is composed by plants that have at least one but less than four 'high' scores (i.e. partial adopters) and the third group is composed by plants with four 'high' scores (i.e. full adopters). Table 6 reports the main characteristics of the three resulting groups in terms of number of plants from each country, percentage of plants from each industry, percentage of WCM and traditional plants, mean and standard deviation values for each SCI scale. As it can be expected, the partial adopters cluster contains numerous plants, because it represents a wide and heterogeneous group of plants in terms of SCI. Additional analyses in order to better characterize partial adopters are provided in section 3.4.

Once the groups were created, we compared their performance, based on a pair-wise t-test method. Table 7 shows the results of these tests. It reveals that full adopters have a better performance compared to non-adopters, confirming Hypothesis 1. In fact product quality, delivery and flexibility performance are significantly better (p-value < 0.01) and also efficiency (p-value < 0.05) compared to non-adopters. Moreover, full adopters outperform partial adopters in terms of product quality, delivery (p-value < 0.01), flexibility and efficiency (p-value < 0.05). Finally, partial adopters do not have a significant better efficiency, product quality, delivery and flexibility performance than non-adopters. However, given that the heterogeneity of partial adopters could determine biased results in terms of performance differences, in order to provide conclusive evidence about hypotheses 2 and 3, we ran some additional analyses, as provided in section 3.4.

Table 6. sub-samples distribution according to country, industry, WCM vs. traditional manufacturing, mean values and variance values of SCI practices.

	Non adopters	Partial adopters	Full adopters
Number of plants	67	187	63
Country			
Austria	5	8	8
China	13	27	11
Finland	4	18	8
Germany	12	19	10
Italy	5	17	5
Japan	9	21	5
South Korea	7	18	6
Spain	4	21	3
Sweden	4	18	2
United States	4	20	5
Industry			
Electronics	26%	38%	33%
Machinery	41%	32%	27%
Transportation	33%	30%	40%
Type of manufacturing			
World Class Manufacturing	43%	46%	56%
Traditional	57%	54%	44%
Mean (standard deviation)			
Internal integration	4.41 (0.56)	5.02 (0.61)	5.69 (0.42)
Supply chain planning	4.51 (0.48)	5.22 (0.50)	5.77 (0.38)
Supplier involvement	5.01 (0.40)	5.55 (0.47)	6.00 (0.38)
Customer involvement	4.86 (0.41)	5.41 (0.45)	5.91 (0.35)

Table 7. Operational performance differences between groups and group sizes.

Group	Quality	Delivery	Flexibility	Efficiency	Plants
Non adopters	3.80[a]	3.55[a]	3.69[a]	3.21[c]	67
Partial adopters	3.83[b]	3.77[b]	3.78[c]	3.28[d]	187
Full adopters	4.10[a,b]	4.08[a,b]	4.05[a,c]	3.51[c,d]	63

[a,b] Mean difference significant at 0.01 level.
[c,d] Mean difference significant at 0.05 level.

In addition, in order to avoid endogeneity and potential biases that may affect the results of our analyses, we controlled for the effect of some variables. Firstly, we checked for differences between the three groups as regards country, industry and type of manufacturing because the nature of the business, national culture, and technologies adopted can determine differences in the level of SCI implementation and, given the same level of SCI implementation, can determine differences in operational performance. Table 6 shows that the three groups are stratified to approximate equal distribution across countries, sectors and type of manufacturing, thus ensuring that these characteristics don't influence the level of SCI implementation. Moreover, we checked whether these variables influence operational performance by dividing our three a-priori groups into sub-groups by country, then sector, and finally type of manufacturing. We compared the performance of the sub-groups with the same level of SCI implementation, based on a pair-wise t-test method, and we didn't find any statistically significant difference. Then, we checked for differences as regards imports, exports and plant size. In fact, the level of plant internationalization and resources available can influence SCI implementation. We used the percentage of purchases that come outside the home country in order to measure imports, the percentage of sales made to customers outside the home country in order to measure exports, and the log of the total number of employees to measure plant size. We found that none of these variables was significantly different across the three a-priori groups (i.e. full, partial and non-adopters). In addition, we considered product life cycle in order to verify whether market dynamism can predict differences in SCI adoption. We used the log of the average product life cycle and again we didn't find any difference among the three groups. Finally, we controlled for the effect of a plant's position along the supply chain, as it can influence the SCI practices implemented upstream and downstream. In order to measure supply chain position, we used the scale of McKone-Sweet and Lee (2009), which considers plant's percentage of sales for each types of customers (i.e. end consumers, retailers, wholesalers, distributors, assemblers, and manufacturers), and calculates a weighted average by assigning a weight to each type of customer from 1 (end consumers) to 6 (manufacturers). Again, we did not find any relation between the supply chain position and level of SCI adoption.

3.4 Additional analyses

Given that partial adopter cluster includes heterogeneous plants in terms of SCI, we performed some additional explorative analyses to deepen our understanding of what are the most common SCI configurations characterizing partial adopters and if they differ in terms of operational performance.

Following Hair *et al.* (1998)'s two-step cluster approach, firstly we adopted a hierarchical clustering procedure to determine the number of clusters, then a k-mean clustering procedure to classify the final clusters. Within the partial adopter group, it is possible to distinguish between three SCI configurations, as reported in Table 8. The first group of plants - partial adopters 1 - is characterized by a high level of supplier and customer involvement, a medium level of supply chain planning (similar to the mean value of the overall sample, as reported in Table 8) and a low internal integration. Instead, partial adopters 2 have a high level of internal integration, a medium supplier involvement and low levels of supply chain planning and customer involvement. Finally, partial adopters 3 are characterized by high levels of internal integration and supply chain planning, a medium customer involvement and a low supplier involvement.

After this cluster analysis, we compared the performance of all the five groups (i.e. non-adopters, partial adopters 1, partial adopters 2, partial adopters 3, and full adopters), based on a pair-wise t-test method. This comparison is useful because drawing rigorous conclusions about performance differences between full, partial and non-adopters, by simply comparing these three groups (Table 7) can be risky, given the heterogeneity of partial adopters. The results of these tests reported in Table 9 reveal that while partial adopters 1 and partial adopters 2 have a statistically significant lower performance compared to full adopters and no performance differences compared to non-adopters, confirming Hypotheses 2 and 3b respectively, partial adopters 3 only partially confirm theses hypotheses as these plants don't have a statistically significant lower quality and efficiency compared to full adopters, and their delivery performance is higher compared to non-adopters (p-value < 0.05). Finally, full adopters outperform partial adopters 3 in terms of delivery and flexibility (p-value < 0.05).

To conclude, taken together, the analyses run (Tables 7 and 9) led to the results summarized in Table 10.

Table 8. Mean values of SCI practices for the non-adopters, the three partial adopters and the full adopters groups

Group	Internal integration	Supply chain planning	Supplier involvement	Customer involvement	Plants
Non adopters	4.41	4.51	5.01	4.86	67
Partial adopters 1	3.50	5.29	6.17	5.67	71
Partial adopters 2	5.50	3.96	5.50	5.15	54
Partial adopters 3	5.75	6.30	5.25	5.40	62
Full adopters	5.69	5.77	6.00	5.91	63
Overall mean	*5.03*	*5.20*	*5.53*	*5.40*	*317*
Median	*5.08*	*5.23*	*5.54*	*5.42*	*317*

Table 9. Operational performance differences between non adopters, partial adopters 1, partial adopters 2, partial adopters 3 and full adopters

Group	Quality	Delivery	Flexibility	Efficiency	Plants
Non adopters	3.80[a]	3.55[a,e]	3.69[a]	3.21[c]	67
Partial adopters 1	3.77[b]	3.61[b]	3.74[b]	3.16[d]	71
Partial adopters 2	3.81[c]	3.77[c]	3.77[c]	3.28[e]	54
Partial adopters 3	3.92	3.87[d,e]	3.86[d]	3.39	62
Full adopters	4.10[a,b,c]	4.08[a,b,c,d]	4.05[a,b,c,d]	3.51[c,d,e]	63

[a,b] Mean difference significant at 0.01 level.
[c,d,e] Mean difference significant at 0.05 level.

Table 10. Summary of main results found.

Group	Evidences	Hypotheses
Non adopters	They underperform full adopters in all the performance dimensions They underperform partial adopters 3 in terms of delivery	H1 held H3a partially held
Partial adopters 1 Partial adopters 2	They underperform full adopters in all the performance dimensions They do not significantly differ from non-adopters in any performance dimension They do not significantly differ from partial adopters 3 in any performance dimension	H2 held Partial adopters 2 H3b held (H3a contrasted)
Partial adopters 3	They have a better delivery than non-adopters They underperform full adopters in terms of delivery and flexibility They do not significantly differ from partial adopters 1 and 2 in any performance dimension	H3a partially held H2 partially held
Full adopters	They have a better performance compared to non-adopters They outperform partial adopters 1 and 2 in all the performance dimensions They outperform partial adopters 3 in terms of delivery and flexibility	H1 held H2 held if we consider partial adopters 1 and 2; H2 partially held if we consider partial adopters 3

4. Discussion

This paper provides several contributions for academics and practitioners. Firstly, as we expected, our results reveal that plants which extensively adopt all SCI practices (i.e. full adopters) perform better compared to those which do not implement any SCI practice (non-adopters) in terms of quality, delivery, flexibility and efficiency. Compared to partial adopters (i.e. plants implementing only a partial set of SCI practices), full adopters outperform partial adopters 1 - which are plants highly integrated with customers and suppliers, with a medium level of supply chain planning and a low internal integration - and partial adopters 2 - i.e., plants with a high level of internal integration, but with a medium supplier involvement and low levels of supply chain planning and customer involvement – in all operational performance dimensions. In addition they exceed partial adopters 3, characterized by high levels of internal integration and supply chain planning, a medium customer involvement and a low supplier involvement, in terms of delivery and flexibility. This finding gives a further evidence to support previous papers that empirically proved the positive relationship between SCI and performance (Fabbe-Costes and Jahre 2007, van der Vaart and van Donk 2008, Sofyalioglu and Öztürk 2012), and in line with Frohlich and Westbrook's (2001) seminal study confirms that companies with the 'greatest arcs of integration' have the largest rates of performance improvement. However, compared with these studies, this research goes more in-depth in explaining the link between SCI and performance, by providing also an interpretation of why in some cases companies fail to achieve significant performance improvements through SCI.

In fact, a second and more relevant contribution is related to the importance of considering the configurational nature of SCI, when studying the link between SCI and performance. As highlighted in the literature review section, several theories, such as TCA, KBV or Organizational Information Processing theory, have been used to explain the positive relationship between SCI and performance. This research supports the need of complementing these theories with a configurational perspective because this can help to interpret the mixed results found in the literature on the SCI-performance link. In fact, the present research not only examines whether full SCI adopters in general perform better than non-adopters or partial adopters, but also analyzes the unanswered question concerning the effects of a partial SCI integration. The results found on partial integration suggest that the relationship between SCI and operational performance is not straightforward, and that a configurational approach is needed to explain the dynamics of SCI and its link with performance. In particular, partial adopters 1 and partial adopters 2 do not significantly differ from non-adopters in terms of quality, delivery, flexibility and efficiency performance. Instead, partial adopters 3 configuration has an effect on performance. In fact, they have a better delivery compared to non-adopters (even though worse than full adopters), and their quality and efficiency performance, even though not statistically different from non-adopters, is not significantly worse compared to full adopters.

Thus, our results partially contrast previous studies proving that companies which lever on a selected set of SCI practices (such as partial adopters 1 and 2) can obtain some performance improvements anyway (Closs and Savitskie 2003, Humphreys *et al*. 2004, Corsten and Felde 2005, Fynes *et al*. 2005, Sahin and Robinson 2005). Only if we consider partial adopters 3, we can conclude that the set of SCI practices adopted, even though partial, can lead to some performance improvements. This means that limiting SCI to some specific practices may not improve any operational performance, while only some configurations of partial adopters can lead to a higher performance. These results, together with the performance differentiation of full adopters compared to non-adopters and partial adopters, clearly support the need of adopting a configurational perspective of SCI, in order to exploit potential synergies between SCI practices (McKone-Sweet and Lee 2009, Flynn *et al*. 2010, Danese 2013).

This means also that even though it is important to distinguish between the specific practices of SCI in order to analyze and understand their peculiarities, when the aim is measuring the SCI effect on performance, it is vital to use a broader scale (e.g. Zailani and Rajagopal 2005, Kannan and Tan 2010) in order to control any possible effect of integration and in particular potential synergies and complementarities between practices. For this reason, we conceptualized SCI as a multi-dimensional variable, and operationalized it by using four different scales in order to cover all the multiple facets of SCI (i.e. internal integration, supply chain planning, supplier and customer involvement). This research testifies the importance of developing and using adequate SCI scales and frameworks in order to elaborate robust theories on the SCI-performance link. Any analysis limited only to a specific subset of integration practices could not detect a significant relationship, given that it overlooks any potential synergic effect. By recognizing the configurational nature of SCI, some previous studies investigated the profiles or patterns of SCI and studied their links with performance (Frohlich and Westbrook 2001, McKone-Sweet and Lee 2009, Flynn *et al*. 2010). In line with these studies, the present research demonstrates that the best performance is achieved by plants which extensively implement all the SCI practices. In addition, it is interesting to compare the results of our taxonomy with Flynn *et al*.'s (2010) work. The pattern of partial adopters 3 is similar to Flynn *et al.*'s (2010) 'High Customer Leaning' pattern, which includes companies with high levels of internal and customer integration, and a low supplier integration. In Flynn *et al*. (2010), the High Customer Leaning pattern shows a similar operational performance compared to the so-called 'High Uniform' pattern, characterized by high levels of all SCI practices, i.e. internal, customer and supplier integration. Our study supports this finding by proving that partial adopters 3 and full adopters do not significantly differ if we consider some operational performance dimensions, such as quality and efficiency. However, compared to previous studies, a contribution of this research is that it deepens the link between SCI and operational performance, by distinguishing between quality, delivery, flexibility and efficiency, rather than considering operational performance as a unique construct. In addition, this research, by including supply chain planning which explicitly measures the integration of plans in the plant's supply chains, strives to go beyond a dyadic perspective when studying SCI.

A further relevant contribution of this research concerns the issue of synergies in SCI. In fact, by comparing practices adopted by partial adopters 1, 2 and 3, and full adopters, our research contributes to knowledge by suggesting the existence of some synergic effects between SCI practices. On the one hand, this represents an interesting starting point for future studies which intend to deepen the phenomenon of complementarities/synergies in SCI, and on the other hand, it is also a valuable result for practitioners to understand how to maximize SCI effect on performance.

First of all, based on literature, a potential interpretation of results found suggests the existence of a synergy between internal integration and supply chain planning practices. In fact evidences from partial adopter comparison, reveal that, when implemented together, these practices can lead to some performance improvements (e.g., partial adopters 3 extensively implement both practices) whereas, when one of these is missing, the results on performance may be compromised (e.g., partial adopters 1 and 2). Therefore, it seems essential to start the SCI journey from internal integration and supply chain planning.

The importance of internal integration as a moderator of the external SCI-operational performance link is widely recognized in the literature (Droge *et al*. 2004, Germain and Karthik 2006). In fact, several authors (Flynn *et al*. 2010) argued that companies should start with internal integration since it acts as the foundation for customer and supplier integration. Even when supply chain planning is high, a low internal integration - as it happens for example to partial adopters 1 - can generate inefficiencies that can result in disruptions in the material flows, and thus can offset potential operational performance improvements. For example, when internal functions are not integrated, schedule nervousness problems (Ren 2003, Terwiesch *et al*. 2005) are typically amplified, because promptly aligning the activities of all functions to new and fresh information from the market and include it into the distribution, production or purchasing plans is difficult, and this causes scheduling updating problems and delays, which in turn deteriorate operational performance. Vice versa, internal integration is not sufficient to obtain distinctive operational performance without an adequate supply chain planning (partial adopters 2). In fact, supply chain planning allows to align and monitor activities and plans along the whole supply chain, thus avoiding sub-optimization and preventing potential problems in the logistics process. Results found concerning partial adopters 3 suggest that if plants have high levels of both internal integration and supply chain planning, they can achieve some performance advantages, in particular in terms of delivery. For instance, these practices are considered very powerful in smoothing out the bullwhip effect due to the ability of reducing information distortions along the supply chain, and in turn this increases delivery performance (Lee *et al*. 1997).

Finally, coherently with the configurational theory, the maximum performance improvements can be achieved when plants adopt all the SCI practices, i.e. internal integration, supply chain planning, supplier and customer involvement. A potential explanation is that supplier and customer involvement, together with internal integration and supply chain planning, help to develop a strategic integration, based on working closely to solve problems and collaborative relationships, which allows to avoid schedule nervousness issues, abnormal and opportunistic behaviours which, as recognized by several authors (Danese 2006, Das *et al.* 2006, Swink *et al.* 2007), can limit operational performance improvements.

From a managerial point of view, we think that our results can have important implications for practice. Firstly, they may give guidance about what pitfalls companies should avoid in order to successfully implement SCI. Managers should bear in mind that a partial SCI could not always guarantee a performance improvement. In order to achieve a full competitive advantage, companies should simultaneously lever on multiple SCI practices, i.e. internal integration, supply chain planning, supplier and customer involvement, as this is fundamental to exploit all the synergies resulting from their combined use. However, since companies generally have limited resources and integrating the whole supply network is a very complex task, SCI practices are usually implemented gradually. Our results highlight that the implementation sequence of SCI practices matters, and in particular our research suggests to start with internal integration and supply chain planning to obtain preliminary improvements on performance, and afterwards complete the SCI journey by levering on customer and supplier involvement to achieve a robust and significant competitive advantage. In fact, full adopters outperform non-adopters and partial adopters 1 and 2 in terms of product quality, delivery, flexibility and efficiency, and partial adopters 3 in terms of delivery and flexibility.

Linked to this, a further interesting contribution for managers is that the effect of SCI is cumulative, and this provides significant insights for companies in implementing it. In fact, the sequence of SCI above mentioned may help to cumulatively increase operational performance. Enhancing initially internal integration and supply chain planning can determine a significant improvement in term of delivery, and also quality and efficiency increase, even though more marginally. Afterwards, by levering on customer and supplier involvement, it is possible to reap the full benefits of SCI, by maximizing its positive effect on all the performance dimensions. In fact, delivery performance further increases, quality and efficiency improvements become more evident, and finally plants can achieve significant results also in terms of increased flexibility.

Finally, our results highlight a critical issue for managers which needs to be further investigated. In fact, we found that partial adopters 1 and 2 do not significantly differ from non-adopters, and we argued that synergic effects between SCI practices count. However, the present research only analyzes whether in general, given a certain SCI configuration, the plant improves, or does not, its performance. It may be also that the external context influences the effectiveness of a SCI configuration. Thus, further research could clarify whether in some contexts, partial adopters 1 and 2 outperform non-adopters due to the fit between the SCI practices implemented and the external environment.

4.1 Limitations and future research

Our research has some limitations that suggest some directions for future research. A first limit is linked to the cross-sectional nature of the data analyzed. We divided our sample into plants that have different levels of SCI implementation and tested whether these groups showed differences in their operational performance. We found that full SCI adopters had a superior performance, and that only a particular configuration of partial adopters (i.e. partial adopters 3) showed results similar to full adopters in terms of quality and efficiency. Starting from our analyses, we suggested a possible sequence of SCI, i.e. starting with internal integration and supply chain planning, and then levering on supplier and customer involvement. However, further research is needed to provide conclusive evidence on the optimal sequence of SCI implementation to be undertaken. In fact, cross-sectional data does not guarantee methodological and statistical accuracy when studying the implementation sequence of SCI, while for managers is vital to know how proceeding in integrating the whole supply network and how sequencing SCI initiatives. Thus, we call for longitudinal case studies to corroborate our preliminary findings on the right sequence to optimize the transition from a non-integrated to a fully integrated supply network.

Furthermore, our results suggest that synergies between SCI practices cannot be ignored, and based on the literature we advance some arguments supporting potential synergies, e.g. between internal integration and supply chain planning, or between internal integration, supply chain planning and supplier and customer involvement. An opportunity for future research is investigating more in detail the mechanisms through which complementarities between SCI practices operate, e.g., how SCI practices interact thus influencing a firm's performance or, conversely, how the absence of a practice can generate obstacles thus erasing the potential benefits of other practices.

A further limit of this research concerns the level of analysis, i.e. plant. Even though this choice has some advantages, as explained in the section 2.1, it has also several limitations linked to the risk of collecting responses by not informed respondents with a limited knowledge of the company SCI strategy. Instead, studying integration at a corporate level usually allows to involve respondents with a more complete understanding of SCI decisions. However, in both cases (i.e., level of analysis at a company or plant level), several authors (e.g., Seuring 2008) recommend not only to administer the survey questionnaires to respondents within the plant/company, but also to collect data from all supply chain partners, positioned in different tiers.

In addition, although this research provides some interesting findings about the relationship between SCI and performance, it classifies the level of adoption of each SCI practice by assigning a

high- or low-implementation value to the plants above or below the median respectively. Instead, by considering the real extent of adoption of each practice, future studies could investigate whether a minimum level of adoption for each SCI practice exists which should be reached in order to avoid compromising the effect of the other SCI practices.
Finally, another interesting area of research is the factors that influence the degree of internal integration, supply chain planning, and supplier and customer involvement in the SCI patterns. In this research, we controlled for the effects of several contextual factors, such as country, industry, type of manufacturing, imports, exports, plant size, product life cycle and supply chain position. Future research could examine the impact of other contextual factors on SCI patterns and their relationship with performance, e.g. the organizational culture or cross-culture differences between supply chain partners. Linked to this, a further limit of this research is that it only analyzes whether through a certain SCI configuration a plant can achieve a superior performance but, as before explained (section 4), each configuration may have a different effect in different contexts. Thus, further research should investigate, according to a contingency perspective, whether and under what contextual conditions a certain SCI configuration is especially useful.

5. **Conclusions**

This study contributes to the research stream on the link between SCI and performance, by investigating whether full SCI adopters - i.e. plants extensively adopting all the SCI practices classified in this research into internal integration, supply chain planning, customer and supplier involvement - achieve a superior performance compared to plants implementing only some selected SCI practices (i.e. partial adopters) and compared to plants which do not implement any SCI practice (non-adopters). It also examines what benefits partial adopters could achieve compared to non-adopters. Results found highlight that, as expected, full adopters exceed non-adopters in all the operational performance dimensions, i.e., quality, delivery, flexibility and efficiency. Among partial adopters, only a particular SCI pattern (i.e. partial adopters 3), characterized by a high level of internal integration and supply chain planning, differs from non-adopters. In particular, it has a better delivery than non-adopters and, also shows results similar to full adopters in terms of quality and efficiency. Instead, the other groups of partial adopters (i.e. partial adopters 1 and 2) do not significantly differ from non-adopters, and their operational performance is significantly worse than full adopters, in terms of quality, delivery, flexibility and efficiency. This provides a number of original implications for the interpretation of the relationship between SCI and performance. In fact, in line with a configurational view of SCI, these results empirically prove that a successful SCI implementation requires that companies lever on all SCI practices and integrate processes along the whole supply network to obtain a sustainable competitive advantage. In addition, since only in some cases of partial integration (i.e. partial adopters 3), the set of SCI practices adopted led to some performance improvements, we can argue also that the implementation sequence of SCI practices is crucial. In fact, by starting with the implementation of certain practices, i.e. internal integration and supply chain planning, and then levering on supplier and customer involvement, companies can cumulatively increase their operational performance towards a full exploitation of SCI benefits.

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APPENDIX

SUPPLY CHAIN INTEGRATION

Please indicate to what extent you agree/disagree with the following - (circle one number): 1 – strongly disagree, 2 – disagree, 3 – slightly disagree, 4 – neutral, 5 – slightly agree, 6 – agree, and 7 – strongly agree

Internal integration	
II1	The functions in our plant are well integrated.
II2	Problems between functions are solved easily, in this plant.
II3	Functional coordination works well in our plant.
II4	Our business strategy is implemented without conflicts between functions.

Supply Chain Planning
We actively plan supply chain activities.
We consider our customers' forecasts in our supply chain planning.
We strive to manage each of our supply chains as a whole.
We monitor the performance of members of our supply chains, in order to adjust supply chain plans.
We gather indicators of supply chain performance.

Supplier involvement
We are comfortable sharing problems with our suppliers.
In dealing with our suppliers, we are willing to change assumptions, in order to find more effective solutions.
We believe that cooperating with our suppliers is beneficial.
We emphasize openness of communications in collaborating with our suppliers.

Customer involvement
We frequently are in close contact with our customers.
Our customers give us feedback on our quality and delivery performance.
Our customers are actively involved in our product design process.
We strive to be highly responsive to our customers' needs.
We regularly survey our customers' needs.

OPERATIONAL PERFORMANCE IN RESPECT TO COMPETITORS

Please circle the number that indicates your opinion about how your plant compares to its competitors in your industry, on a global basis: 5 – superior, 4 – better than average, 3 – average or equal to the competition, 2 – below average, and 1 – poor or low

Q1	Quality conformance
Q2	Product capability and performance
DEL1	On-time delivery performance
DEL2	Fast delivery
FLEX1	Flexibility to change product mix
FLEX2	Flexibility to change volume
EFF1	Unit cost of manufacturing
EFF2	Inventory turnover

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