Supply chain integration framework using literature review

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1. Introduction

The globalisation and rapid developments in the information technologies are changing today's inter-organisational relationships. Competition is no longer among firms, but among supply chains (SCs) (Christopher 2000, Ketchen and Hult 2007). Today's manufacturers must not only manage their own organisations but also be involved in the management of the network of upstream and downstream firms (Handfield and Nichols 1999, Mikkola and Skjøtt-Larsen 2004, Zhang et al. 2010). Increasing global competition has caused organisations to rethink the need for cooperative, mutually beneficial SC partnerships (Lambert and Cooper 2000, Wisner and Tan 2000, Hvolby et al. 2007) and the joint improvement of inter-organisational processes has become a high priority (Zhao et al. 2008). Supply chain management (SCM) has strategic relevance as a source of competitive advantage (Christopher 1992, Fine 1998, Alfalla-Luque and Medina-Lopez 2010). Managing SC effectively has become critical for the survival and growth of organisations (Alfalla-Luque and Medina-Lopez 2009, Arana-Solares et al. 2011).

Ideally, the entire SC processes need to be designed, managed and coordinated as a unit (Cooper et al. 1997, Bagchi et al. 2005a). Accordingly, the integration of the SC is a key element in the SCM strategy (Cigolini and Rossi 2008). Previous studies, both empirically and theoretically agree that the higher the level of integration with suppliers and customers, the greater the potential benefits (Frohlich and Westbrook 2001, Rosenzweig et al. 2003, Bagchi et al. 2005a, Li et al. 2009). However, studies have not found always a clear relation between the level of SCI and the performance improvement (Hertz 2001, Swink et al. 2007).

Over the years, several definitions and measures of SCI have been proposed (Flynn et al. 2010). A wide range of different studies on SCI have been carried out, many of them focusing on the relationship between SCI and performance (e.g. Frohlich and Westbrook 2001, Quesada et al. 2008, Sezen 2008, Kim 2009, Vallet Bellmunt 2010). Analysis of these papers reveals that great varieties of dimensions and variables and a broad spectrum of scales have been used for measurements of SCI. Many authors develop new models with new constructs and new measurement scales. While a few authors consider SCI through unidimensional constructs (e.g. Dong et al. 2001, Cousins and Menguc 2006, Sezen 2008), others use multi-dimensional constructs for measuring SCI (e.g. Bagchi et al. 2005a, Koufteros et al. 2007, Kim 2009, Vijayasarathy 2010). Very few papers employ the same SCI dimensions and variables for specific region, country or industry. There is, therefore, a lack of clear definitions and understanding of the concept of SCI (Pagell 2004, Fabbe-Costes and Jahre 2008).

In the above view, it is necessary to take a step back and ask oneself what defines SCI. This research contributes to the SC literature by: (1) clarifying the SCI concept, (2) identifying key dimensions and variables for SCI and (3) developing a conceptual framework for measuring SCI. This article identifies holistic multi-dimensional SCI constructs for future empirical research and industry applications.

This article is organised as follows. Section 2 demonstrates the review of prior works on SCI. Section 3 describes the methodology employed to achieve the objectives of this study, including article selection and the method of assessment. Section 4 identifies the key dimensions and variables for SCI and develops a conceptual framework for SCI. Section 5 discusses the contribution of this research and gives suggestions for further research. Finally, Section 6 presents the main conclusions.

2. Literature review on SCI

2.1. SCI concept

It is apparent from the previous researches that SCI has different meanings to different researchers and organisations. To some authors, the concept of integration is implicit in the very definition of SCM. As such, Cooke

(1997) defines SCM as the successful coordination and integration of all the activities associated with moving goods from the raw materials stage through to the end user for sustainable competitive advantage. Lummus and Vokurka (1999) use very similar terms when they state that SCM coordinates and integrates into a seamless process of all the activities involved in delivering a product from raw material to the customers, including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer and manage information systems necessary to monitor all of these activities. According to Lambert and Cooper (2000), SCM is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders. Similar definitions of SCM have been provided by Handfield and Nichols (2002) or Cooper et al. (1997). Such definitions emphasise the importance of the integration of flow of products, services, funds and information across firms for an effective SCM.

A few authors give specific definition of SCI. Romano (2003) describes the concept of integration as a mechanism to support business processes across the supply network to overcome intra- and inter-organisational boundaries. For Cagliano et al. (2006) SCI is strictly related to coordination mechanisms and in particular implies that business processes should be streamlined and interconnected, both inside and outside company boundaries. Elsewhere, Bagchi et al. (2005a) have defined SCI as comprehensive collaboration between SC network members in strategic, tactical and operational decision-making. The last definition highlights the need for integration at all the levels of planning in order to be effective. While operational coordination can only lead to operational benefits, strategic coordination provides both operational and strategic benefits (Sanders 2008).

SCI implies collaborative inter- and intra-organisational management on the strategic, tactical and operational levels of activities (and their corresponding materials, funds and information flows) that, starting with raw materials suppliers, add value to the product to satisfy the needs of the final customer at the lowest cost and the greatest speed (Monczka and Morgan 1997, Frohlich and Westbrook 2001, Romano 2003, Chen et al. 2004, Bagchi et al. 2005a, Cagliano et al. 2006, Flynn et al. 2010). Chopra and Meindl (2010) demonstrate that achieving strategic fit between competitive and SC strategies is the key to SCI. Therefore, the researches on SCI should consider not only tactical and operational issues but also strategic aspects of business.

2.2. SCI approaches

Previous studies analyse and measure SCI considering three main approaches: (1) external (with supplier and customer) and internal integration, (2) process integration and (3) information/data and physical/materials flows integration.

SCI needs both intra- and inter-company integration across the entire SC in order to work as a single entity (Poirier and Bauer 2001, Pagell 2004). However, organisations are not always successful in achieving higher level of integration within their SCs. Many organisations have only achieved the first tier backward or forward integration (Mejza and Wisner 2001, Fawcett and Magnan 2002, Bessant et al. 2003). Some studies show that one of the reasons that hinders the achievement of a high-level external integration is low level of internal integration (Gimenez and Ventura 2005). Intra-company integration is the starting point for broader integration across the SC (Simchi-Levi et al. 2000, Fawcett and Magnan 2002, Harrison and Van Hoek 2005, Sridharan et al. 2005; Cagliano et al. 2006). One of the major obstacles to fully integrate materials and information flows across the SC is the inadequacy of the internal management systems of the individual firms (Mentzer 2004). In order to achieve intra-organisational integration, coordination between functions is critical (Fawcett and Magnan 2002). Consequently, SCI aims to break down the organisational boundaries between functions and barriers between organisations.

Although the internal and external integration is the key element for SCI, there is much emphasis on customer and supplier integration only, ignoring the important central link of internal integration (Flynn et al. 2010). For example, Fawcett and Magnan (2002) classify three types of integration: backward integration, forward integration and complete forward and backward integration. Similarly, Frohlich and Westbrook (2001) use this perspective to define

arcs of integration: inward-facing, periphery-facing, supplier-facing, customer-facing and outward-facing. Other papers have adopted a wider focus and have considered both types of integration (internal and external). For example, Narasimhan and Kim (2002) indicate three levels of integration – company integration with suppliers, company integration with customers and internal integration. Flynn et al. (2010) indicate three SCI dimensions: customer, supplier and internal integration.

The second approach comprises of SCI from process integration perspective. Lambert and Cooper (2000) propose that, for successful implementation of SC, all firms within an SC must overcome their own functional silos and adopt a process approach. The key processes typically include customer relationship management, customer service management, demand management, order fulfilment, manufacturing flow management, supplier relationship management, product development and commercialisation and returns management. Moreover, Romano and Vinelli (2001) maintain that even quality management can be considered as a key SC business process. SC business process integration involves collaboration between buyers and suppliers, joint product development, common systems and shared information. Some authors have analysed SCI using this approach. For example, Bagchi et al. (2005a) analyse the relative degree of the involvement of key suppliers and customers in decision making in new product development, inventory management, procurement, production and distribution. Ragatz et al. (1997) and Koufteros et al. (2007) investigate the consequences of supplier integration in product development activities.

Finally, some papers focus on the integration of information/data and physical/materials flows. For example, Cagliano et al. (2006) investigate the relationship between the integration of information flows and the integration of physical flows and two manufacturing improvement programmes (lean production and enterprise resource planning systems). Other studies analyse the information flows integration: Van Hoek (1998), Nguyen and Harrison (2004), Nurmilaakso and Kotinurmi (2004), Bagchi et al. (2005a), Stevenson and Hendry (2007) or Li et al. (2009).

The previous approaches on SCI are not exclusive. Usually, at least customer and supplier integration (not always internal integration) is used when the research focus on process or physical/information flow integration. For example, Narasimhan and Das (2001) distinguish between customer integration, information integration, logistics and distribution integration and supplier integration.

There are different approaches to measure SCI. The dimensions and variables used for SCI in the previous researches have a wide variety. It is clear from previous research that SCI suffers from a lack of clarity in its definitions, dimensions and variables. Additionally, the concepts of SCI are incomplete as it seldom considers important central link of internal integration (Flynn et al. 2010). Even, some authors comment that SCI is in its infancy (Devaraj et al. 2007, Arshinder et al. 2008, Flynn et al. 2010). Researchers find significant differences in the dimensions and variables used to measure SC integration (Ho et al. 2002, Van der Vaart and Van Donk 2008). Therefore, it becomes necessary to conduct a literature review to identify dimensions and variables and develop a conceptual framework for SCI.

3. Methodology

Following the methodology successfully used in previous papers (Gunasekaran and Ngai 2005, Van der Vaart and Van Donk 2008, Barragán Ocaña 2009, Fabbe-Costes et al. 2009), this study reviews prior research publications. A critical review of the literature (Medina-Lopez et al. 2010) on SCI was undertaken in relevant Operations Management (OM) and Supply Chain/Logistics Management journals in order to identify dimensions and variables of SCI. The number of literature on SCM is growing rapidly (Alfalla-Luque and Medina-Lopez 2009). Therefore, it is very important to focus on only the papers that deal with SCI. The objective of this literature review is not to make a classic synthesis of what has been published on SCI, but to define SCI clearly and to identify dimensions and variables for integration across the SC with the purpose of developing a conceptual framework for integration.

In order to achieve the above objective, 13 major academic journals in Supply Chain/Logistics Management and OM have been identified (Table 1). The selection of the journals for this study is guided by journal rankings and citation index. As per Harzing (2010), Interfaces, International Journal of Operations and Production Management (IJOPM),

International Journal of Production Economics (IJPE), International Journal Production Research (IJPR), Journal of Operations Management (JOM), Management Science (MS), Omega, International Journal of Logistics Management (IJLM), International Journal of Physical Distribution and Logistic Management (IJPDLM), Journal of Business Logistics (IJBL), Journal of Supply Chain Management (JSCM) and Supply Chain Management: An International Journal (SCMIJ) are ranked high and referred in the area of OM/SCM. The Association of Business School in their Academic Journal Quality Guide (2010) recommends these 12 journals for academic publications. Additionally, many UK-based Business Schools have ranked Supply Chain Management Review (SCMR) in their list of journals. Similarly, several studies in SCM (e.g. Fabbe-Costes and Jahre 2008, Van der Vaart and Van Donk 2008, Fabbe-Costes et al. 2009, Hsieh and Chang 2009, Piercy et al. 2009, Holsapple and Lee-Post 2010) select Interfaces, IJOPM, IJPE, IJPR, JOM, MS, Omega, IJLM, IJPDLM and JBL as leading OM/SCM journals.

Table 1. Distribution of selected papers by journals.

Journal	Number of selected papers	References	Methodology
Interfaces	–		
International Journal of	2	Bagchi *et al.* (2005a)	E (survey)
Logistic Management		Gimenez and Ventura (2003)	E (survey)
International Journal of	4	Cagliano *et al.* (2006)	E (survey)
Operations and Production		Gimenez and Ventura (2005)	E (survey)
Management		Tan *et al.* (2002)	E (survey)
International Journal of	2	Vachon and Klassen (2006)	E (survey)
Physical Distribution &		Mollenkopf and Dapiran (2005)	E (survey)
Logistics Management		Hsu *et al.* (2008)	E (survey)
International Journal of	2	Kim (2009)	E (survey)
Production Economics		Wong and Boon-itt (2008)	E (case studies)
International Journal of	1	Vachon and Klassen (2007)	E (survey)
Production Research		Germain and Iyer (2006)	E (survey)
Journal of Business Logistics	4	Rodrigues *et al.* (2004)	E (survey)
		Sanders and Premus (2005)	E (survey)
		Stank *et al.* (2001)	E (survey)
Journal of Operations	13	Cousins and Menguc (2006)	E (survey)
Management		Das *et al.* (2006)	E (survey)
		Devaraj *et al.* (2007)	E (survey)
		Dong *et al.* (2001)	E (survey)
		Droge *et al.* (2004)	E (survey)
		Frohlich and Westbrook (2001)	E (survey)
		Koufteros *et al.* (2007)	E (survey)
		Narasimhan and Kim (2002)	E (survey)
		Rosenzweig *et al.* (2003)	E (survey)
		Sahin and Robinson (2005)	E (simulation)
		Stock *et al.* (2000)	E (survey)
		Swink *et al.* (2007)	E (survey)
		Vickery *et al.* (2003)	E (survey)
Journal of Supply Chain	2	Sanders (2005)	E (survey)
Management		Petersen *et al.* (2008)	E (survey)
Management Science	1	Kulp *et al.* (2004)	E (survey)
Omega	1	Kannan and Tan (2005)	E (survey)
Supply Chain Management Review	1	Lee (2000)	C
Supply Chain Management: An	3	Briscoe and Dainty (2005)	E (case studies)
International Journal		Quesada *et al.* (2008)	E (survey)
		Sezen (2008)	E (survey)
Total	36		
Note: Conceptual (C)/Empirical (E).			

A search of articles published between 1999 and 2009 identified 325 papers with the words integration and logistics or supply in the title, keywords or abstract. Subsequently, the abstracts and contents were assessed for suitability of these papers for the present study. After focusing on the articles that have analysed/defined the SCI with respects to dimensions and/or variables, 36 papers were finally selected. Table 1 shows the distribution of these papers by journals and methodology (empirical or conceptual). A wide majority were empirical research based on survey.

A systematic content analysis of 36 papers was undertaken for identifying dimensions and variables for SCI and developing the conceptual SCI framework. Each of the selected papers was thoroughly studied and the SCI dimensions and variables were identified and analysed. While gathering information on dimensions and variables of SCI from prior research, the complementary papers of the authors of above 36 papers have also been looked into (e.g. Sahin and Robinson 2002, Bagchi et al. 2005b).

4. SC integration

4.1. Key dimensions and variables in previous research

As indicated in previous sections, SCI has been studied from several perspectives and there are varied dimensions and variables for measuring SCI. This is mainly due to the lack of clarity of the concept of SCI. While few authors examine SCI through a single construct (Table 2), others consider SCI through multi-dimensional constructs (Table 3). Multi-dimensional approaches receive greater attention because of complexity of the concept of SCI.

Table 2. SCI as a mono-dimensional construct in previous studies.

Article	Supplier (S), Internal (I) or Customer (C) scope	Dimension analysed
Briscoe and Dainty (2005)	S/I/C	Supply chain integration
Cousins and Menguc (2006)	S	Supplier integration
Dong *et al.* (2001)	S/C	Supply chain integration
Frohlich and Westbrook (2001)	S/C	Supply chain integration
Kannan and Tan (2005)	S/C	Supply chain integration
Petersen *et al.* (2008)	S	Supplier integration
Rosenzweig *et al.* (2003)	S/I/C	Supply chain integration
Sanders (2005)	S	Buyer–supplier integration
Sezen (2008)	S/C	Supply chain integration
Tan *et al.* (2002)	S/C	Supply chain integration
Vickery *et al.* (2003)	S/I/C	Supply chain integration

Continuing…

Table 3. SCI as a multi-dimensional construct in previous studies.

Article	S/I/C scope	Dimensions analysed
Bagchi *et al.* (2005a, b)	S/C	Information sharing and communication across the SC Collaboration and shared decision-making with network partners Collaboration leading to risk, cost, and gain sharing or incentive alignment Sharing of skills, ideas and institutional culture (operational and strategic collaboration) Organisation
Cagliano *et al.* (2006)	S	Integration of information flows Integration of physical flows
Das *et al.* (2006)	S/I	External integration practices (supplier integration) Internal integration practices (supplier integration)
Devaraj *et al.* (2007)	S/C	Supplier production information integration Customer production information integration
Droge *et al.* (2004)	S/I/C	External strategic design integration Internal design-process integration
Germain and Iyer (2006)	I/C	Internal integration Downstream integration
Gimenez and Ventura (2003)	S/I/C	Internal integration External integration
Gimenez and Ventura (2005)	S/I/C	Internal integration: logistics production Internal integration: logistics marketing External integration
Hsu *et al.* (2008)	S/C	Information sharing Buyer–supplier relationship
Kim (2009)	S/I/C	Company's integration with suppliers Cross-functional integration within a company Company's integration with customers
Koufteros *et al.* (2007)	S	Black-box supplier integration Gray-box supplier integration
Kulp *et al.* (2004)	S/C	Information sharing Collaboration
Lee (2000)	S/I/C	Information integration Coordination and resource sharing Organisational relationship linkages
Mollenkopf and Dapiran (2005)	S/I/C	Customer integration Internal integration Material/service supplier integration Technology and planning integration Relationship integration
Narasimhan and Kim (2002)	S/I/C	Company's integration with suppliers Internal integration across the SC Company's integration with customers
Quesada *et al.* (2008)	S/C	Customer integration Supplier integration
Rodrigues *et al.* (2004)	S/I/C	Integrated internal operations Integrated external operations
Sahin and Robinson (2002, 2005)	S/I/C	Degree of information sharing Decision-making coordination
Sanders and Premus (2005)	S/I/C	Internal collaboration External collaboration
Stank *et al.* (2001)	S/I/C	Internal collaboration External collaboration
Stock *et al.* (2000)	S/I/C	Internal logistics integration External logistics integration
Swink *et al.* (2007)	S/I/C	Strategic customer integration Strategic supplier integration Product–process technology integration Corporate strategy integration
Vachon and Klassen (2006, 2007)	S/C	Logistical integration with suppliers Logistical integration with customers Technological integration with suppliers Technological integration with customers
Wong and Boon-itt (2008)	S/I/C	Internal integration Supplier integration Customer integration

When SCI has been investigated as monodimensional construct, the variables are very different in number and focus. It has been observed that SCI constructs are built from three (Vickery et al. 2003) or four items (Dong et al. 2001, Rosenzweig et al. 2003, Cousins and Menguc 2006) to eight items (Frohlich and Westbrook 2001, Briscoe and Dainty 2005). The diversity of the items was very wide. For example, Rosenzweig et al. (2003) measured the SCI constructs through the question: How integrated is your business unit's SC? (1) Integrated closely within your own organisation (cross-functional), (2) integrated closely with raw material supplier, (3) integrated closely with distributors/retailers, and (4) integrated closely with customers. The above measures of SCI are very different from the study by Frohlich and Westbrook (2001), where SCI considers items like (1) access to planning systems, (2) sharing production plans, (3) joint EDI access/networks, (4) knowledge of inventory mix/levels, (5) packaging customisation, (6) delivery frequencies, (7) common logistical equipment and containers and (8) common use of third-party logistics. In another study, Vickery et al. (2003) define SCI constructs by means of three items, such as (1) supplier partnering, (2) closer customer relationships and (3) cross-functional teams. These three examples reveal the non-uniformity of SCI constructs and clearly show the need for establishing consensus constructs for SCI in order to pursue further research.

Few authors have considered SCI through multi-dimensional constructs. Different dimensions are used to characterise the SCI concept. Sahin and Robinson (2002, 2005) proposed the degree of information sharing and decision-making coordination as two major dimensions of SCI at the operational level. Lee (2000) outlined three

dimensions of SCI: information integration (II), coordination and resource sharing (CRS) and organisational relationship linkage (ORL). Bagchi et al. (2005b) categorised SCI into five interrelated dimensions: information sharing and communication across the SC, collaboration and shared decision-making with network partners, collaboration leading to risk, cost and gain sharing (operational and strategic collaboration), sharing of skills, ideas and institutional culture and organisation. The SCI dimensions identified by Lee (2000) and Bagchi et al. (2005b) are quite similar. The first two dimensions are similar and the third dimension indicated by Lee (2000) matches with the last three, as indicated by Bagchi et al. (2005b).

The most common approaches used are focused on inter- and intra-company integration (see Table 2 and 3). Although internal integration is a pre-requisite to achieve external integration, several papers focus only on external integration with suppliers (e.g. Cagliano et al. 2006, Cousins and Menguc 2006, Das et al. 2006, Koufteros et al. 2007) or with suppliers and customers (e.g. Dong et al. 2001, Frohlich and Westbrook 2001, Bagchi et al. 2005a, Vachon and Klassen 2006, 2007, Devaraj et al. 2007, Quesada et al. 2008, Sezen 2008). Only one selected paper differentiates between integration of information flows and physical flows (Cagliano et al. 2006). Others focus on the integration of production information flows of suppliers and customers (Devaraj et al. 2007).

Table 4 summarises the characteristic of the selected papers. It shows the predominance of the concept of SCI as a multi-dimensional construct (69.4%) and that the research on both external and internal integration (47.2%) is the lowest. Most of the papers focus only on supplier and/or customer integration.

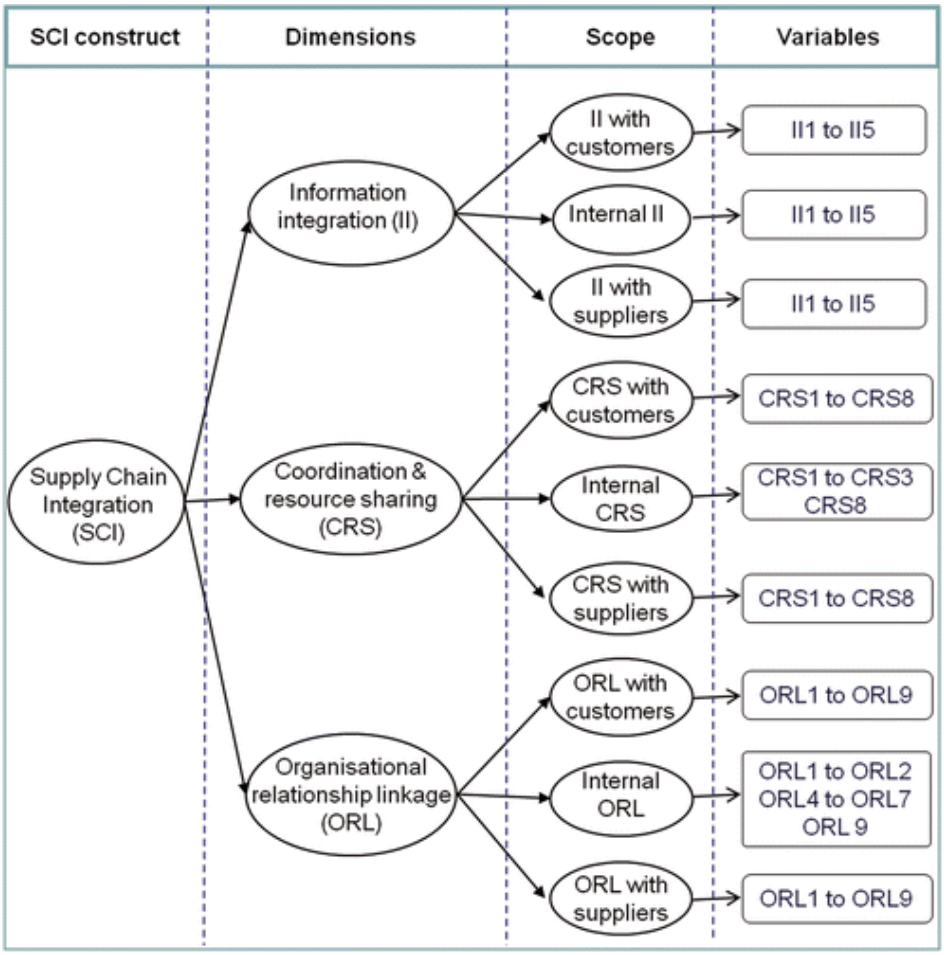
Table 4. Classification of SCI selected paper.

	Number of papers	Percentage (%)
Mono-dimensional construct	11	30.6
Multi-dimensional construct	25	69.4
Supplier integration	36	100.0
Customer integration	30	83.3
Internal integration	19	52.8
Supplier and customer integration	29	80.6
External and internal integration	17	47.2
Total	36	–

4.2. A conceptual SCI framework

The above paragraphs clearly depict the lack of consensus on SCI dimensions and variables and the need for the development of conceptual framework with SCI dimensions and variables that could be used across industries and regions to achieve comparable results. Based on the prior research on SCI constructs, a conceptual framework has been developed. The evidences show that SCI is possible through multi-dimensional constructs. The SCI involves both internal and external aspects of business. The key to SCI is to develop uninterrupted link with upstream suppliers and downstream customers along with total functional synergy internally. Therefore, integration could be achieved through three major interrelated activities – customer relationship management, internal SCM and supplier relationship management. In other words, the role of SCM is to integrate both customers and suppliers with the client's business processes. In the above view, as Lee (2000) proposes, information integration, CRS and ORL have been considered as SCI dimensions in this study. Figure 1 shows three-tier SCI framework. The proposed framework helps researchers understand every dimension and variable for SCI and allow practitioners to measure the level of integration and identify measures for improvement.

Figure 1. Proposed SCI framework (see variables in Table 5).



According to Lee (2000), information integration refers to the sharing of information internally and between the members of the SC, including demand information, inventory status, promotion plans, sales forecasts and production schedules. The members also collaborate in establishing joint demand and replenishment forecasts. CRS refers to the realignment of decisions and resources intra- and inter-organisationally. The reorganisation of outsourcing and logistical aspects is especially significant in this dimension. Finally, ORL involves stable interactions and transparent relationships between the SC members, which entails, among other things, common visions and objectives, incentive realignment, sharing of skills, ideas and institutional culture and laying down performance measures.

Table 5 shows the variables that enable measurement of the three dimensions of SCI. The variables are collated from the literature as shown in column 4 of the table. Additionally, column 3 shows the type of integration (supplier/internal/customer) that each variable facilitates. The last column shows the definition of each variable. The following paragraphs demonstrate dimensions and variables of SCI.

Table 5. Dimensions and variables that define SCI.

Dimensions	Variables	Scope	Authors	Definition
II	II1: Information sharing	S/I/C	Lee (2000), Dong *et al.* (2001), Frohlich and Westbrook (2001), Stank *et al.* (2001), Narasimhan and Kim (2002), Kulp *et al.* (2004), Rodrigues *et al.* (2004), Bagchi *et al.* (2005a, b), Briscoe and Dainty (2005), Gimenez and Ventura (2003, 2005), Mollenkopf and Dapiran (2005), Sahin and Robinson (2002, 2005), Sanders and Premus (2005), Cagliano *et al.* (2006), Das *et al.* (2006), Germain and Iyer (2006), Devaraj *et al.* (2007), Swink *et al.* (2007), Vachon and Klassen (2006, 2007), Hsu *et al.* (2008), Quesada *et al.* (2008), Sezen (2008), Wong and Boon-itt (2008) and Kim (2009)	To share information across the various functional departments of the organisation and with supplier and customer organisations to improve decision-making
	II2: Information technology integration	S/I/C	Stock *et al.* (2000), Dong *et al.* (2001), Stank *et al.* (2001), Tan *et al.* (2002), Droge *et al.* (2004), Bagchi *et al.* (2005a, b), Kannan and Tan (2005), Mollenkopf and Dapiran (2005), Sanders and Premus (2005), Hsu *et al.* (2008), Sezen (2008), Wong and Boon-itt (2008) and Kim (2009)	To make compatible the information systems so as to allow access to information concerning the activity of the company from different departments and companies that make up the SC
	II3: Collaborative planning	S/I/C	Lee (2000), Frohlich and Westbrook (2001), Narasimhan and Kim (2002), Rodrigues *et al.* (2004), Gimenez and Ventura (2003, 2005), Mollenkopf and Dapiran (2005), Sanders (2005), Sanders and Premus (2005), Cagliano *et al.* (2006), Cousins and Menguc (2006), Das *et al.* (2006), Germain and Iyer (2006), Devaraj *et al.* (2007), Vachon and Klassen (2006, 2007), Hsu *et al.* (2008), Quesada *et al.* (2008) and Sezen (2008)	To make available to the various companies with information that allows joint planning that takes into account the constraints of the companies involved and seek to improve the planning process of comprehensive SC
	II4: Joint demand forecasts	S/I/C	Lee (2000), Stock *et al.* (2000), Narasimhan and Kim (2002), Kulp *et al.* (2004), Mollenkopf and Dapiran (2005), Cagliano *et al.* (2006), Das *et al.* (2006), Germain and Iyer (2006), Devaraj *et al.* (2007), Swink et al (2007), Hsu *et al.* (2008), Sezen (2008), Wong and Boon-itt (2008) and Kim (2009)	To have real-time information directly from the end customer to make a common demand forecast in order to avoid disruptions
	II5: Joint replenishment forecasts	S/I/C	Lee (2000), Stock *et al.* (2000), Frohlich and Westbrook (2001), Kulp *et al.* (2004), Germain and Iyer (2006), Devaraj *et al.* (2007), Sezen (2008) and Kim (2009)	To have sufficient information to perform the procurement activities that meet real needs
CRS	CRS1: Shared decision-making	S/I/C	Lee (2000), Bagchi *et al.* (2005a, b), Gimenez and Ventura (2003, 2005), Sahin and Robinson (2002, 2005), Das *et al.* (2006), Germain and Iyer (2006) and Kim (2009)	To involve to the SC members in decision making and to delegate to the member with the best negotiating position to lead the relevant decision making
	CRS2: Cooperation	S/I/C	Stock *et al.* (2000), Stank *et al.* (2001), Tan *et al.* (2002), Rodrigues *et al.* (2004), Bagchi *et al.* (2005a, b), Kannan and Tan (2005), Sahin and Robinson (2002, 2005), Germain and Iyer (2006), Koufteros *et al.* (2007), Vachon and Klassen (2006, 2007) and Hsu *et al.* (2008)	To realise of joint actions to achieve the same end
	CRS3: Work realignment	S/I/C	Lee (2000) and Quesada *et al.* (2008)	To plan the workload in a balanced way among the links in the SC
	CRS4: Reorganisation of outsourcing. Common use of third-party logistics	S/C	Lee (2000), Frohlich and Westbrook (2001), Gimenez and Ventura (2003, 2005) and Quesada *et al.* (2008)	To search for an optimal subcontracting for the entire SC, with special emphasis on logistics providers
	CRS5: Packaging customisation/standardisation	S/C	Frohlich and Westbrook (2001) and Quesada *et al.* (2008)	To design and joint development of packaging to facilitate handling and transport, reduce costs and ensure quality
	CRS6: Agreements on delivery frequency	S/C	Frohlich and Westbrook (2001), Cagliano *et al.* (2006) and Quesada *et al.* (2008)	To search optimisation in the procurement and distribution of materials throughout the SC
	CRS7: Common use of logistical equipment/containers	S/C	Frohlich and Westbrook (2001) and Quesada *et al.* (2008)	To use of containers, packaging and transportation common to facilitate handling operations, loading and unloading
	CRS8: Process integration	S/I/C	Stank *et al.* (2001), Tan *et al.* (2002), Droge *et al.* (2004), Rodrigues *et al.* (2004), Bagchi *et al.* (2005a, b), Kannan and Tan (2005), Sanders and Premus (2005), Cagliano *et al.* (2006), Cousins and Menguc (2006), Das *et al.* (2006), Koufteros *et al.* (2007), Swink *et al.* (2007), Vachon and Klassen (2006, 2007), Hsu *et al.* (2008), Quesada *et al.* (2008), Wong and Boon-itt (2008) and Kim (2009)	To use a process approach that allows the direct interconnection between departments and companies and avoids duplication
ORL	ORL1: Design and maintaining of communication channels	S/I/C	Lee (2000), Tan *et al.* (2002), Kannan and Tan (2005), Das *et al.* (2006), Germain and Iyer (2006), Swink *et al.* (2007), Hsu *et al.* (2008) and Sezen (2008)	To communicate using active communication channels with members of the SC
	ORL2: Laying down performance measures	S/I/C	Lee (2000), Stank *et al.* (2001), Bagchi *et al.* (2005a, b), Swink *et al.* (2007) and Hsu *et al.* (2008)	To establish common performance indicators and aligned/consensus that reveal the evolution from the stated objectives
	ORL3: Incentive realignment	S/C	Lee (2000), Frohlich and Westbrook (2001), Dong *et al.* (2001), Stank *et al.* (2001), Bagchi *et al.* (2005a, b), Briscoe and Dainty (2005), Gimenez and Ventura (2003, 2005), Mollenkopf and Dapiran (2005), Sahin and Robinson ((2002, 2005), Das *et al.* (2006) and Swink *et al.* (2007)	To share risks, costs and rewards (operational and strategic collaboration)
	ORL4: Integrated behaviour	S/I/C	Stock *et al.* (2000), Stank *et al.* (2001), Bagchi *et al.* (2005a, b) and Swink *et al.* (2007)	To promote attitudes and plans of action to promote an integrated business performance
	ORL5: Joint establishment of objectives for all parties in the chain	S/I/C	Briscoe and Dainty (2005), Gimenez and Ventura (2003, 2005), Das *et al.* (2006) and Kim (2009)	To guide organisations towards a joint search for the end customer satisfaction
	ORL6: Sharing of skills, ideas, and institutional culture	S/I/C	Dong *et al.* (2001), Droge *et al.* (2004), Bagchi *et al.* (2005a, b), Briscoe and Dainty (2005), Das *et al.* (2006), Vachon and Klassen (2006, 2007) and Hsu *et al.* (2008)	To disseminate of best practices among members of the SC
	ORL7: Drawing up of contingency plans for quick problem solving	S/I/C	Bagchi *et al.* (2005a, b) and Briscoe and Dainty (2005)	To establish procedures under the normal order of the company against possible environment or business unexpected situations
	ORL8: Forging and maintaining long-term relationships	S/C	Narasimhan and Kim (2002), Vickery et al (2003), Droge *et al.* (2004), Bagchi *et al.* (2005a, b), Briscoe and Dainty (2005), Sanders (2005) and Wong and Boon-itt (2008)	To establish stable links with partners to enable mutual trust
	ORL9: Creating teamwork along SC and cross-functional teams	S/I/C	Vickery et al (2003), Rodrigues *et al.* (2004), Bagchi *et al.* (2005a, b), Gimenez and Ventura (2003, 2005), Sanders (2005), Sanders and Premus (2005), Das *et al.* (2006), Germain and Iyer (2006) and Kim (2009)	To encourage team building to allow for coordination and active cooperation between members of different departments and companies in the SC

The integration of the organisations should start with the exchange of information as it is one of the key factors for SC improvement (Lee 2000, Frohlich and Westbrook 2001, Mentzer et al. 2001, Bagchi et al. 2005a, Paik and Bagchi 2007, Hernández et al. 2008, Moyano Fuentes 2010, Moyano Fuentes et al. 2012). For the overall organisational performance improvement, it is necessary that the exchange of information to be perfect (Gavirneni et al. 1999) and the managers choose appropriate information for exchange (Zhou and Benton 2007). The flow of information directly impacts production plans, inventory control and distribution plans (Lee et al. 2004). Therefore, organisations must implement a strategy for integration with the SC partners (Akkermans et al. 1999, Caskey et al. 2001, Jain et al. 2009).

CRS looks for synergy based on trust and the dependence between SC members. However, it is not easy to break down departmental and business barriers and adopt a strategy of process integration. When the coordination between the members of the SC is not sufficient, some imbalances could exist between the capacity and the production planning. Therefore, the work realignment is essential. The logistic aspects are very important too. Reorganisation of the outsourcing, packaging customisation/standardisation, agreements on delivery frequency and common use of logistical equipment have a high impact in cost, quality and speed. However, not all suppliers or customers are going to have the same level of integration, as this will depend on the mutual interest of the companies (Lambert et al. 1999, Bagchi and Skjoett-Larsen 2002).

A clear strategic vision is needed in the ORL in order to achieve common visions and objectives, share risk, reduce cost, promote rewards, develop skills and institutional culture and define joint performance measures. It is necessary to design communication channels and create cross-functional teams along the SC. In recent years, many organisations have changed attitude towards their customers and suppliers. Today focal organisation seeks to work together with their customers and suppliers to plan and operate for greater success than work in isolation (Simatupang and Sridharan 2002). Therefore, building long-term relationships among the SC members is necessary to develop SCI.

Integration with the upstream suppliers are possible through information sharing and communication across the SC, the presence of multiple contact points across the SC, regular contact at top/senior levels, standardised operating procedure throughout the SC, compatible information systems with real time linking of network partners, common database, collaboration and shared decision-making with network partners, managing SC risk in an integrated way, sharing skills, ideas and institutional culture, exchange of skilled man power, formation of specialist team with the involvement of all the partnering organisation and frequent technology forums. Integration with the downstream customers could be achieved through appropriate trade-off between customers' responsiveness and efficiency with respect to SC drivers – facilities, transportation, inventory and information. Other activities that help keep dynamic customer contacts also strengthen SCI. Additionally, products/services design and plant operations by addressing customers' requirements dynamically keep customers integrated with the SC.

Intra-organisational integration is possible through developing appropriate synergy between each SC drivers (e.g. facility utilisation and inventory policy, inventory policy and warehousing, logistics and information, etc.). Integrating sourcing with all the drivers together or separately helps integrate entire SC. All the functional synergies will also ensure SCI. Intra-organisational SCI is possible through synergic decisions in all the three levels of decision-making – strategic, tactical and planning.

Additionally, the proposed framework is capable to measure and benchmark the level of SCI. The steps that could be undertaken in order to measure SCI are selecting an SC, identifying the relevant variables for SCI from the list of the variables, as shown in Table 5, deriving proxies for each variables, determining the importance of SCI variables, gathering information on SCI against each proxy through interviewing the key stakeholders, deriving strengths and weaknesses of SC and suggesting improvement measures. Similar steps could be adopted for benchmarking SCI of participating supply networks.

5. Discussion

SCI is relatively new as an area of research (Flynn et al. 2010). There is little consensus on how to capture the essence of SCI (Van der Vaart and Van Donk 2008). The wide variety of dimensions and variables revealed in previous research for defining SCI makes it difficult to compare their findings. Very few researchers employ the same dimensions and variables for SCI. Therefore, a review of existing literature is essential to create a reference framework on which future research could be based for the consolidation of the knowledge in SCI. This would allow studying SCI across industries and regions, which will enable benchmarking exercise on SC effectiveness. It is necessary to reach into consensus on the definition of SCI and its dimensions and variables in order to build SCI theory. Several examples of conceptual discrepancies in SCI constructs have been pointed out in this research along with descriptions of mono and multi-dimensional constructs for SCI (Table 2 and 3).

Previous SCI researches indicate varied dimensions and variables. For example, Kannan and Tan (2005) created a model with four constructs, namely JIT, TQM, Performance and SCM. The SCM construct is sub-divided into SCI, SC coordination, SC development and information sharing. However, Lee (2000) and Bagchi et al. (2005a, b) considered SC coordination and Information sharing as dimensions of the SCI. In another study, Vickery et al. (2003) considered integrative information technologies and SCI as different dimensions. Further, Sezen (2008) established three different constructs – SCI, information sharing with suppliers and information sharing with customers. Similarly, Tan et al. (2002) considered an information sharing construct separately from SCI. These examples reinforce the need to create a conceptual framework about SCI.

Additionally, some papers focus only on external integration (e.g. Frohlich and Westbrook 2001, Vachon and Klassen 2006, 2007, Quesada et al. 2008) and others have a broader inter- and intra-organisational scope (e.g. Narasimhan and Kim 2002, Sanders and Premus 2005, Wong and Boon-itt 2008).

Perhaps, the lack of consensus on the level of SCI and performance (e.g. Gimenez and Ventura 2005, Sahin and Robinson 2005, Swink et al. 2007, Van der Vaart and Van Donk 2008) could be attributed to the different dimensions and variables used to measure the SCI in each research and different scopes of these studies. Other reasons could be that the studies focus on different industries. It could be further analysed whether each dimension and variable has the same impact on performance depending on the region, sector or type of product. Flynn et al. (2010) state that it is unclear whether the relationship between SCI and performance is the same in different countries or industries. For example, in the car industry, external integration does not lead to a competitive advantage because it is a prerequisite to survive, and almost all companies have implemented it (Gimenez and Ventura 2003). Hence, SCI studies in specific country and industry employing the same SCI dimensions and variables are required in order to achieve comparable results.

This study proposes a multi-dimensional SCI framework for future research (refer Figure 1). It takes three dimensions (information integration, CRS and ORL) into consideration and these are analysed from both the inter- and intra-organisational perspectives. The proposed model defines the variables on which a company should act in order to improve the level of integration. It should be highlighted that SCI is not only a process and technique, it also has important human and organisational behaviour components. Therefore, formal and informal communication, collaboration and joint agreements between companies are indispensable elements for SCI to be successful. Organisations must expand their internal integrated behaviour to customers and suppliers through external integration. SCI needs to be included in the organisational culture. SCI is a result of human interactions which can be supported, but not be replaced by information technologies (Sanders 2007). SCI needs SC orientation across suppliers and customers in various tiers. Mentzer et al. (2001) define SC orientation as recognising strategic implications of materials, funds and information flow across the entire SC stakeholders. A firm has SC orientation if its management can see the implications of managing the upstream and downstream physical and information flows. Therefore, SCI needs both strategic and operational focus (Lambert et al. 1998, Fabbe-Costes et al. 2009).

Further research will test several propositions using this conceptual framework. First, despite the importance that internal integration has for achieving inter-organisational integration (Rosenzweig et al. 2003), some papers focus only on external integration. However, the literature suggests that firms must achieve a relatively high degree of collaboration among internal processes before initiating external integration (Simchi-Levi et al. 2000, Fawcett and Magnan 2002, Harrison and Van Hoek 2005, Sridharan et al. 2005, Cagliano et al. 2006). Therefore, we set the following propositions for future research.

Proposition 1
There is a positive relationship between the levels of internal and external integration.

Proposition 2
Firms achieve a relatively high degree of internal integration before implementing external integration.

Second, several papers have analysed some aspects of the SCI dimensions: information integration (e.g. Vickery et al. 2003, Cagliano et al. 2006, Devaraj et al. 2007, Hsu et al. 2008, Sezen 2008), coordination (e.g. Kannan and Tan 2005, Sahin and Robinson 2005) and ORL (e.g. Kulp et al. 2004, Mollenkopf and Dapiran 2005). But the relationship between information integration, CRS and ORL has not been analysed in the literature. Some authors state that the integration of the organisations should start with the exchange of information (Lee 2000, Mentzer et al. 2001, Paik and Bagchi 2007). However, more knowledge is needed with respect to the relationships between SCI dimensions. The following propositions are established for further research.

Proposition 3
Information integration, coordination and resource sharing and organisational relationship linkages are positively correlated.

Proposition 4
Firms achieve a relatively high degree in information integration before achieving integration in the remaining dimensions.

The above four propositions should be analysed in different regions and sectors in order to define possible archetypes of integration.

Third, prior research indicates that the relationship between SCI and performance needs greater attention. Researchers generally agree that a higher level of SCI positively influences the performance of the focal organisation and its supply network (Frohlich and Westbrook 2001, Rosenzweig et al. 2003, Vickery et al. 2003, Bagchi et al. 2005a). Studies have not achieved clear results in this topic (Rodrigues et al. 2004, Gimenez and Ventura 2005, Sahin and Robinson 2005, Swink et al. 2007). For example, Sahin and Robinson (2005) concluded that the major benefit of SC collaboration comes from improved coordination, while information sharing unlocks only a small portion of the potential benefits associated with channel integration. Rodriguez et al. (2004) concluded that if internal and external operations are separated, there may not be much impact on performance. However, when internal and external operations are integrated with each other along with internal business processes, there is a positive impact on performance. Therefore, the following propositions could be considered for further research.

Proposition 5
Internal integration has a positive effect on performance.

Proposition 6
External integration has a positive effect on performance.

Proposition 7
Internal and external integration have a joint positive effect on performance.

Proposition 8

Information integration has a positive effect on performance.

Proposition 9
Coordination and resource sharing has a positive effect on performance.

Proposition 10
Organisational relationship linkages has a positive effect on performance.

Proposition 11
SCI has a positive effect on performance.

Additionally, the relative importance of each variable on overall performance could be tested. This will classify the variables in accordance to their importance for achieving superior organisational performance.

6. Conclusions
This article contributes to build the SCI – dimensions, variables and framework. The literature review shows that SCI is a complex and not well-defined construct. Some authors have defined it as a mono-dimensional construct, but the majority of the selected papers defines SCI as a multi-dimensional construct. Based on the previous studies, a multi-dimensional conceptual framework has been proposed (Figure 1). The developed dimensions and variables incorporate the complexity of the concept. The proposed SCI dimensions (information integration, CRS and ORL) across the SC, considering both internal and external integration with customers and suppliers, provides a solid basis for analysing the questions indicated in Section 5 and any other related issues and challenges within SCI.

The proposed SCI framework has practical implications also. It offers managers to reveal the variables and the level of integration for their SC. Additionally, it helps measure effectiveness of SCI and means for improvement. Using the conceptual framework and taking into account their sector, companies could establish the current SCI level. For this, they could identify the relevant variables in each dimension for its own SC, derive proxies for each variables, gather information on SCI against each proxy through interviewing the key stakeholders and derive strengths and weaknesses of SC. Likewise, SCI opportunities and threats could be analysed in order to determine the expected SCI level in coming years and adopt the appropriate strategic, tactical and operational measures to achieve the desired level. The proposed SCI framework enables achieving superior SC performance by analysing the level of integration, identifying rooms for improvement and developing means for achieving excellence.

This study has two main limitations, such as no primary research was carried out to validate the proposed framework and the limited number of journals that were analysed to develop the conceptual framework. However, the selected journals that are used in this study are relevant to Operations Management, Logistics and SCM and have very high-impact factors. Hence, they are a good sample for interpreting any data. Additionally, they have been used in prior literature review for researching SCI.

The proposed SCI framework (Figure 1) opens up further research opportunities such as pursuing empirical research on industry-specific SCI dimensions and variables, case studies on what makes SC integrated and how SCI dimensions and variables help achieve superior performance.

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