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Additional Information

A guide for supply chain integration in SMEs

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Supply chain integration (SCI) is a competitive business approach for enterprises that has not been implemented as widely as expected in small and medium-sized enterprises (SMEs). One of the factors explaining this low level of application is the lack of methodologies to develop SCI that fit the characteristics of this type of enterprise. In this article, we present a methodology that enables SMEs to achieve correct SCI in a manner that is simple, straightforward and oriented towards their particular characteristics. Thus, SMEs will be able to align and coordinate the aims, resources, decisions, methods, business processes and employees involved in the supply chain. The methodology addresses the problem of SMEs SCI and it was produced by applying the case study research method to 30 industrial SMEs. The methodology is organised in phases and the activities to be performed, the techniques and supporting tools to be used, as well as the expected outcomes are all described for each phase. With this methodology, it becomes possible to overcome the main barriers that prevent SMEs from achieving a correct integration of their supply chains. In addition to the methodology, this article also outlines the significant benefits observed in the 30 enterprises as a result of its application.

Keywords: supply chain integration; SME; case study; logistics; measurement/methodology; KPI

1. Introduction

To remain competitive, enterprises have begun to rethink many of the management models that, until now, they have considered valid. This change in outlook can be explained by a number of different factors, the most important of which include: (1) the fact that enterprises are finding themselves almost forced to open up to international markets due to the phenomenon of globalisation; (2) the increasing demand from customers for a greater variety of products, with a high level of quality, short delivery times, very competitive prices and high quality after-sales service; (3) the new possibilities in business management afforded by computer support tools and (4) the deep recession suffered by financial markets around the world.

Within this framework, one of the areas in which important efforts are being made to cut costs and improve efficiency is in the relations the firm has with its stakeholders in the supply chain (Ballou 2004). *Supply chain management* (SCM) has, therefore, become a strategic goal and is now seen as a key competitive factor (Tan *et al.* 2002) that is essential to be able to compete in markets that are increasingly

more global, dynamic and aggressive (Giunipero *et al.* 2006).

One of the fundamental aspects involved in accomplishing SCM is to achieve supply chain integration (SCI) (Forker *et al.* 1997), which consists in aligning and coordinating the resources, decisions, methods, business processes and employees of the different stakeholders in the supply chain to improve their ability to work together in a continuous improvement process (Chalmeta and Grangel 2003).

SCI is one of the most significant challenges in the modern management of small and medium-sized enterprises (SMEs) (Gélinas and Bigras 2004) and, as reported by Chen *et al.* (2004), yields different kinds of benefits that include reduced costs, increased revenue, enhanced (end) customer satisfaction, improved on-time delivery, reduced supply chain costs, reduced time in the provisioning and quality control processes, reduced work in process and final products stocking, automated processes, standardised production, improved payment process, improved distribution process and improved global competitiveness, improved services, improved quality, improved pipeline visibility (that is the visibility of each of the

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activities of the supply chain by each of the partners), and improved demand visibility by each of the partners, and so forth.

SMEs are defined as 'Enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro' (European Commission 2003). This need for SMEs to manage their supply chains in a suitable manner and achieve a high degree of integration can also sometimes be imposed from outside by the large enterprises (LE) that the SMEs, where small businesses act as an ancillary or first and second tier suppliers in their supply chain (Thakkar *et al.* 2008) or as subcontracted firms, because integration is essential to these large firms in order for them to become more efficient.

As Tan *et al.* (2006) state, given the limited resources within SMEs, they would reap more benefits from greater efforts to integrate with other SMEs, since they can then tap into each other's expertise. SCI is, therefore, one of the most prevalent issues facing SMEs (Lewis 2005).

From our experience in SCI in real-world situations and in accordance with other authors, such as Vaaland and Heide (2007), Thakkar *et al.* (2009) or Quayle (2003), who highlight the common weaknesses found in SCI methods in practice, SCI in SMEs has received little attention in comparison to LE. Thakkar *et al.* (2008) identified the main reasons explaining this lack of integration in the supply chains of SMEs with respect to LEs as the following: (1) the lack of internal integration in SMEs (Singh 1998); (2) lack of understanding on merits and demerits of alliances (Power 2006); (3) poor use of IT (Ritchie and Brindley 2000); (4) immature buyer-supplier relationship (Arend and Wisner 2005); (5) absence of performance measurement (Quayle 2002, 2003) and (6) poor strategic vision (Oakes and Lee 1999, Harland *et al.* 2007).

However, despite the scarcity of SCI in SMEs, SCI research tends to be focused more towards large-scale organisations. This shortage of research studies that analyse SCI from the perspective of SMEs is confirmed by authors such as Sastry (1999), who identified the fact that research has focused more on the SCI of large firms than on SMEs and that a complete transformation of SMEs from a myopic view to a collaborative and integrated approach is needed. A further example is that of Arend and Wisner (2005), who observed that the literature appears unresolved regarding the fit between SCI-SME.

Thus, and in agreement with the conclusions from the review of the literature on SCI conducted by Cousins *et al.* (2006), at present we are still dealing with an emerging management discipline, where a number

of problems concerning the implementation of SCI in SMEs remain unsolved. One of these problems is that there are no methodologies adapted to the characteristics of SMEs that are capable of offering guidance to facilitate SCI while at the same time reducing the level of complexity (Humphreys *et al.* 2001).

On the one hand, there are traditional reference architectures/methodologies for business integration (Bernus *et al.* 1996), including the CIM-OSA (*Open Systems Architecture*) architecture presented in the ESPRIT programmes of the European Union (number 688, 2422 and 5288) by the AMICE Consortium (Amice 1993); the *GRAI Integrated Methodology* architecture derived from the work carried out by several projects subsidised by the ESPRIT programme of the European Union, such as IMPACS (number 2338) by the *GRAI Laboratory of Bordeaux University* (France) (Doumeings 1992); and the PERA architecture developed by *Purdue University* (USA) (Williams 1993). Nevertheless, these architectures were designed with the general internal integration of the enterprise in mind and, therefore, do not take sufficiently into account the problems that exist within supply chains, especially as far as SMEs are concerned.

On the other hand, there are methodologies that are specifically related to SCM, such as the supply chain operations reference model (SCOR; Supply Chain Council 2008); collaborative planning, forecasting and replenishment (Ireland and Crum 2005); or other methodologies that, despite not being created for this field of application, could also be useful, such as the analytic hierarchy process (AHP) (Bhagwat and Sharma 2007a), APH-pre-emptive goal programming (Bhagwat and Sharma 2009) or asset management tool (Lin *et al.* 2000). However, from the point of view of their applicability to SCI in SMEs, these methodologies present important shortcomings involving the actual parameters used to define the methodology; the high level of requirements as far as human, time or economic resources are concerned; the lack of vision for integrating the chain; or drawbacks due to the problems in defining the key performance indicators (KPIs) (Simatupang and Sridharan 2005).

Hence, there is still room for significant improvement in both the analysis and the theoretical study and practical definition of the methodology, as well as in the development of tools that are suitable for later application in the business world (Storey *et al.* 2006).

To help solve this problem, and following the premises that SCI implementation and maintenance in SMEs must be kept simple (Samaranayake 2002) and carried out with the smallest possible number of changes in the business processes of the organisation (Lamming *et al.* 2000), in this article we propose a

methodology that will enable SMEs to manage their supply chains in an integrated fashion. A case study of 30 SMEs will be used to produce a simple straightforward methodology that is adapted to the specific characteristics of SMEs and which will allow SMEs to overcome the barriers that prevent them from integrating their supply chains properly. The methodology is organised in different phases and makes it possible to: (1) structure and plan SCI within an SME; (2) analyse the environment surrounding the business and that of the actual supply chain; (3) design a performance measurement system that, as pointed out by Leopoulos (2006) quoting Hudson, can give feedback regarding the quality of the decisions; (4) analyse and redesign the main business processes, the activities carried out by human resources, and the computer support system and (5) implement the improvements and monitor the outcomes.

The article is organised as follows: the next two sections present a review of the concept of SCI and an analysis of the current situation as regards the development and implementation of SCI in SMEs, to determine the main barriers preventing integration. Section 4 deals with the application of the case study research method carried out on 30 SMEs, and ends with the formulation of the methodology proposed for SCI and verification of the quality and scientific rigour of the research that was conducted. Section 5 outlines some considerations on the benefits observed by the SMEs that took part in the case study. Finally, Section 6 offers the main conclusions from the research.

2. Concept of SCI

The concept of supply chain can be defined as ‘*a set of three or more entities (organisations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer*’ (Mentzer *et al.* 2001). Although the concept of supply chain is unanimously accepted in the management literature, the same cannot be said of the term SCM, although the insightful works by Gibson *et al.* (2005) and the one mentioned earlier by Mentzer *et al.* (2001) were a valuable aid when it came to obtaining a widely accepted definition of the term.

In this regard, another interesting work is that by Stock and Boyer (2009), which identifies 173 different definitions of the term SCM that have been published in the literature since 1994, thus giving rise to a great deal of confusion among both academic as well as practitioner communities (New 1997, Tan 2001). These variations in the concept of SCM are to be expected to a certain extent because its traditional purchasing role

has been replaced by a focus on outsourcing non-core activities and forming strategic alliances in a global context. The problem is that, as highlighted by Ross (1998), all too frequently the terminology used is excessively complicated, especially for the case of SMEs with simple organisational structures, and this greatly limits the extent to which they are understood and their effectiveness, above all when it comes to their practical application. Thus, for the purposes of this article, it is more useful to identify the fundamental concepts that are common to the most widely accepted definitions, instead of using one particular definition of SCM. From this analysis it can be concluded that, in general, an adequate management of the supply chain is must:

- (1) Choose the most appropriate form of organisation to be adopted in terms of integration and systematic and strategic coordination on a horizontal and/or vertical level, from the end user to the initial supplier who provides products, services and information with added value for customers and any other stakeholder (Mentzer *et al.* 2001).
- (2) Optimise the two-directional flow of goods, services, information, technology, human resources and knowledge among the components of the chain (Otto and Kotzab 2003).
- (3) Accomplish both common and specific goals with the aim of improving long-run performance, both for each business unit and for the chain as a whole (Lummus and Vokurka 1999). These aims will vary according to the area in which they are being contemplated. For instance, from the information technology and operations research perspective, the aim will be to minimise the cost of the flow of products given a particular level of service; from the point of view of the marketing area (Stock and Lambert 2001) the aim will be to satisfy the customer and to reduce the costs in the channel; or, from the system dynamics perspective (Stevens 1989), the goal will be to balance out demand and production, with the added problem of production and inventory management.
- (4) As pointed out by Tan *et al.* (1999, 2002), as well as Akkermans *et al.* (1999), implement a change in culture among the employees in the firms that make up the chain, the aim being to seek a more participatory style of management by introducing into their activities the concept of continuous improvement and the need to be customer-oriented.

From these common concepts it can be deduced that to achieve an adequate management of the supply chain it is necessary to accomplish the integration of the SC (Fawcett and Magnan 2002). Integration, as pointed out by the Council of Supply Chain Management Professionals (2005), allows the entire supply chain to be managed as a single process. In an integrated supply chain, all the functions that make up the supply chain are viewed as a single entity rather than separately as individual functions. The prevailing conventional wisdom in SCM literature is that the more integration is achieved, the better the performance of the supply chain will be (Christopher 1998, Harland *et al.* 1999, Lee 2000). The ideal situation, according to these authors, is for the entire process across the supply chain to be designed, managed and coordinated as a unit. Lee (2000) argued that a truly integrated supply chain did more than just reduce costs, since in fact it also created value for the company, its supply chain partners and its shareholders. In addition, Prahalad and Hamel (1994) and Hammer (2001) suggested that vertical integration should be replaced by virtual integration, where each participant concentrated on those processes that it performs best, leaving the rest to others.

Both SMEs and LEs are seeking ways to integrate their supply chains. In this regard, Charlesworth *et al.* (2002) point out that SMEs are not only seeking ways to integrate the disparate systems within the organisation, but they have also moved to extend the integration beyond the boundaries of the organisation so as to include their suppliers, trading partners and customers. Integrating SMEs with their customers and trading partners will give these enterprises greater competitive advantage to compete with the larger companies or their competitors (Chen *et al.* 2004). Hence, as pointed out by Uden (2007), SCI is an important issue for SMEs and a critical component for enhancing SMEs' competitive advantage.

Several definitions have been proposed for SCI in the literature, without any common agreement being reached about its exact meaning (Lummus *et al.* 2008). In accordance with Bagchi and Skjoett-Larsen (2005), in this article we define SCI as a continuous process of improvement of the interactions and collaborations among supply chain network members to improve their ability to work together to reach mutually acceptable outcomes for their organisation.

This definition of SCI has been discussed in the context of SCM and we consider it for the objectives of this article. However, there are also other approaches to SCI, such as supply chain virtual integration (SCVI). This involves using technology and information to blur the traditional boundaries among

suppliers, manufacturers, distributors, and end users in a supply chain. SCVI is related to leveraging information on the supply chain to realise real-time asynchronous coordination of inter-firm planning and execution in supply networks (Collin and Lorenzin 2006). SCVI, unlike traditional vertical 'contractor-subcontractor' integration, represents the decomposition of the traditional company.

3. SCI in SMEs. Benefits, strengths, threats and obstacles

As pointed out by Meehan and Muir (2008), both large and small enterprises identify SCI as a unique opportunity to obtain competitive advantage over their competitors. Nevertheless, the truth is that in practice SMEs do not include it in their management models and display weaknesses in connection with the conceptualisation, operationalisation and modelling of SCI (Ho *et al.* 2002). In a study conducted by Neuman and Samuels (1996), for example, it was found that only 5% of SMEs could be considered to be actually working under what can be called SCI terms. The scant implementation of SCI in SMEs indicated by this figure was confirmed in another later study conducted by Quayle (2003), where it was shown that only 10% of the SMEs that were analysed had a strategy for implementing SCI and had assigned a member of staff to be responsible for it.

Thakkar *et al.* (2008, 2009) and Arend and Wisner (2005) analysed the literature on supply chains in SMEs from the perspective of their integration and concluded that, given their different management models and resource capacities, the implementation must be undertaken from a different perspective depending on whether it is performed in SMEs or in LEs. The differences between SMEs and LEs go far beyond features such as the number of employees, turnover, and profit and loss statement included in their respective definitions.

Hence, as a first step towards fostering and facilitating a successful SCI in SMEs, it is essential to determine the main benefits that an SME can expect to observe, the SMEs' strong points that can smooth the process of SCI, the threats they will have to cope with if they do not integrate their supply chains and the main obstacles that are hindering its implementation.

With regard to the benefits, the management literature contains a number of works that identify the potential benefits that can derive from the integrated management of the supply chain in SMEs, some of the most notable being Fawcett *et al.* (2008), Meehan and Muir (2008), Chen *et al.* (2004) and

Table 1. Main potential benefits of SCI.

Potential benefits identified	
(1) Lower the cost of labour	(2) Cutting costs
(3) Integration of tasks and shared information	(4) Generate and identify new business opportunities
(5) Collaboration and coordination of all the components of the supply chain	(6) Product innovation lead times
(7) Improvements in inventory management	(8) Cost of new product development
(9) Programming and follow-up	(10) Further performance improvements
(11) Significant improvements in both customer and supplier services	(12) Generation of a coordinated work flow
(13) Sales, purchases, warehousing and production departments can share and process information simultaneously	(14) Increased access to financial support
(15) Clear improvements in the productivity of the operational logistics system	(16) Generation of proactivity with regard to the process of SCI

Leopoulos *et al.* (2007). Table 1 presents the main potential benefits that were identified in these studies.

As regards the strong points of SMEs, which can make their process of SCI easier in relation to LEs, Gélinas and Bigras (2004) underline the following: (1) the extent of the owner-manager's involvement (direct contact with operations); (2) focus on effectiveness rather than efficiency; (3) SME flexibility; (4) simple decision-making process focused on immediate action; (5) the organisational structure of SMEs, which is conducive to internal and external interactivity; (6) incremental, short-term planning; (7) less precise division of responsibility, first because of the limited number of managers in SMEs and second because the owner-manager often takes care of production management; (8) swift market response time and (9) easy integration of suppliers and customers within continuous improvement teams.

On the other hand, Thakkar *et al.* (2009) and Meehan and Muir (2008) identify the threats presumably facing SMEs that do not integrate their supply chains: (1) lack of a proactive attitude towards processes of change; (2) possible shortcomings in the definition of their mission, vision, goals and strategies in their SCM; (3) decreased competitiveness compared to competitors; (4) possible lack of integration and definition in their organisational structure; (5) absence of a suitable model for performance measurement; (6) immature buyer-supplier relationships; (7) lack of understanding on merits and demerits of alliances; (8) non-optimised cycle times and (9) warehouse management problems.

Finally, with respect to obstacles, Table 2 presents the ones that were identified from the extant literature and which have also been identified by the authors in implementing SCI in SMEs. To overcome such obstacles, an analysis is carried out to identify the specific

characteristic of the SME that is causing them and a facilitator is proposed.

Following the model put forward by Meehan and Muir (2008), in the table obstacles have been arranged at three levels: individual, relational and organisational.

- (1) The *individual level* reflects obstacles corresponding to a lack of competencies (knowledge, capacities, skills, attitudes, training) on the part of those working in the supply chain.
- (2) The *relational level* indicates the obstacles that refer to the relationships between the different components of the chain, as well as those that have to do with the actual structure of the organisation; in short, it expresses the role played by the SME itself in the supply chain. Another important obstacle is trust. If trust is present, it can improve the chances of a successful supply chain relationship; if not, transaction costs can rise through poor performance.
- (3) The *organisational level* includes obstacles that have to do with management's involvement in and commitment to SCM, as well as with the decisions concerning the management and control of the supply chain.

These obstacles show that SMEs face a significant risk of losing competitive power compared to LEs – a risk that can be summarised, as pointed out by Wagner *et al.* (2003), in the existence of an important gap between SMEs and LEs with regard to the state of the art of the tools and support systems for performing an effective SCI in SMEs. In short, as stated by Quayle (2003), the methodologies, and consequently the tools and techniques, that SMEs have available for a proper implementation of SCI have received very little attention to date.

Table 2. Characteristics, obstacles and facilitators in the implementation of SCI in SMEs.

Level	Characteristics of SMEs	Obstacles	Authors	Facilitators
Individual	Limited, non-optimised resources	(1) Lack of expert staff to manage the SCI.	Meehan and Muir (2008)	Optimise and prioritise existing resources
		(2) Lack of suitable training.	Fawcett <i>et al.</i> (2008)	
	High turnover of skilled employees	(3) Lack of experience in managing improvement programmes.	Meehan and Muir (2008)	Personal career plan and training
		(4) Lack of knowledge or experience in e-solutions.	Meehan and Muir (2008)	
	Resistance to change	(5) Lack of interest in participating in SCI.	Meehan and Muir (2008)	Motivation and implication in the organisational change process
			(6) Doubts about the benefits to be gained from changing habits.	
Relational	Organisational structures without formally defined levels	(7) Existence of hidden and unsolved inter-functional conflicts.	Fawcett <i>et al.</i> (2008), Mentzer <i>et al.</i> (2000), Moberg <i>et al.</i> (2003), Monczka and Morgan (1997).	Formal definition of the structure of the organisation
		(8) Nobody responsible overall for the whole supply chain.	Meehan and Muir (2008)	
		(9) Lack of trust among the members of the supply chain.	Meehan and Muir (2008)	
	Management that is usually personalised	(10) Lack of support and commitment from Management.	Moberg <i>et al.</i> (2003), Fawcett <i>et al.</i> (2008), Monczka and Morgan (1997).	Management with professional support
			(11) Lack of guidelines from management.	
	Informal and undocumented definition of the Vision and Strategy, these being defined by the owners of the organisation	(12) Lack of SCI Vision.	Moberg <i>et al.</i> (2003), Mentzer <i>et al.</i> (2000), Morgan (1997), Thakkar <i>et al.</i> (2009).	Formal definition of mission, vision, strategy and values
			(13) Lack of trust among the members of the organisation are unaware of the corporate strategy	
	Many members of the organisation are unaware of the corporate strategy	(14) Lack of understanding of the meaning of the concept of SCI.	Moberg <i>et al.</i> (2003)	Implication in the SCM
			(15) Lack of Trust among the members of the organisation.	
	Business in very limited market segments and based on the trust of a few customers	(16) Little willingness to share risks and rewards.	Fawcett <i>et al.</i> (2008).	Integration of tasks and Methods
			(15) Lack of Trust among the members of the organisation.	
	Organisational	Lack of integration between some areas of responsibility because their duties are not fully defined. It is not a priority objective	(16) Little willingness to share risks and rewards.	Fawcett <i>et al.</i> (2008).

(continued)

Table 2. Continued.

Level	Characteristics of SMEs	Obstacles	Authors	Facilitators
		(17) Lack of Integration between the performance measurement methods and the practical requirements necessary for SCI.	Chan <i>et al.</i> (2003), Thakkar <i>et al.</i> (2009).	
		(18) Fragmented approach and lack of integration of SCI.	Monczka and Morgan (1997)	
		(19) Difficulties in measuring SCI.	Monczka and Morgan (1997)	
	Misalignment between Business Strategy and Processes	(20) Inflexibility of the organisational system and the processes.	Fawcett <i>et al.</i> (2008).	Alignment of Strategy and Processes
	Increasingly more difficult to obtain financial resources	(21) Difficulties in gaining access to specialised consultancies.	Quayle (2003)	To share costs with other SMEs
		(22) Price of expensive and complex SCI computer applications.	Quayle (2003)	
	Poor information management	(23) Lack of resources devoted to external communication, while internal communication is swift and quite unstructured.	Fawcett <i>et al.</i> (2008)	Dedicate resources to information management
		(24) Unawareness of the potential advantages of SCI.	Quayle (2003)	
	Widespread application of non-integrated computer management solutions	(25) Inadequate, Deficient or Inexistent. IT/IS.	LaLonde (2003), Mentzer <i>et al.</i> (2000), Monczka and Morgan (1997), Sharma <i>et al.</i> (2008), Thakkar <i>et al.</i> (2009), Bhagwat and Sharma (2007b)	Review and integration of the ICT systems
	The implementation of new technologies is not a priority	(26) Insufficient development of R&D and Innovation programmes.	Vaaland and Heide (2007)	Prioritise implementation of new technologies
		(27) They are not focused on the implementation of EDI or e-solutions in their relationships with the different components of the chain.	Vaaland and Heide (2007)	
		(28) Unawareness of application methodologies.	Vaaland and Heide (2007)	
	Scarce implementation of a prior process to	(29) Badly planned SCI.	Morgan (1997)	Review of goals and strategies

(continued)

Table 2. Continued.

Level	Characteristics of SMEs	Obstacles	Authors	Facilitators
	review Strategy and data analysis			
	Lack of tools for identifying, designing and quantifying performance indicators	(30) Lack of indicators for measuring SCI. (31) Unawareness of the methodology that is best suited to their application.	Mentzer <i>et al.</i> (2000) Vaaland and Heide (2007)	Define suitable methodologies for identifying indicators
	Relatively inexperienced in the use of indicators for business management	(32) Measurement of SCI performance with inconsistent and unsuitable measures. (33) Confusion as regards the number of indicators to be defined and their assignation to the corresponding area. (34) Imbalance between the financial area indicators and those of the other areas.	Tan <i>et al.</i> (1998), Turner <i>et al.</i> (2005), Fawcett <i>et al.</i> (2008), Hofmann and Locker (2009), Thakkar <i>et al.</i> (2009). Gunasekaran <i>et al.</i> (2001) Hudson <i>et al.</i> (2001a)	Define suitable methodologies for identifying indicators

Some of the benefits/obstacles are also benefits/obstacles of effective SCM (read as effective SCI), as effective SCM is a result of effective SCI.

4. Methodological design of the case study

After analysing the characteristics and obstacles that hinder correct integration of supply chains in SMEs, and given the fact that the literature does not contain any suitable methodologies to help with this integration, this article describes a first approach to obtain a methodology, called the SCI-IRIS methodology, which enables SMEs to integrate their supply chains.

The SCI-IRIS methodology was obtained using the case study method. With regard to the validity of using the case methodology for this purpose, Larson and Halldorsson (2004) point out that: *a current research need is to complement conceptual work and surveys on SCI with more longitudinal in-depth research of SCI in action, where case studies and interviews would provide the main sources of evidence.*

The work plan that was followed consisted of seven stages and was based on the inductive analysis of qualitative data (Yin 1994), adapted to Walsham's (1995) proposals for generalisation of a theory from an interpretative investigation:

- (1) Definition of research purposes.
- (2) Definition of the conceptual context, perspectives, Literature review and proposals, Proposed theoretical model.
- (3) Identification of the units of analysis. Case selection.
- (4) Definition of research methods and resources.
- (5) Fieldwork. Data collection, triangulation and classification of information.
- (6) Formulation of the improved SCI-IRIS methodology.
- (7) Verification of the rigour and quality of the study.

We will now go on to describe the process included in each of these phases.

4.1. Definition of research purposes

The aim of this article is to provide an answer to the question being asked in SMEs that are concerned about SCI, i.e. What methodology that has been designed to fit the characteristics of SMEs can help them to integrate their supply chains?

Unfortunately, today the answer to this question is that there are hardly any real practical methodological

frameworks that can be used to allow organisations to integrate their supply chains.

Thus, the intended aim of this study is to provide the business world with a methodology that can help to carry out the implementation of SCI in SMEs in a structured manner. The methodology allows the internal integration of an SME. At the same time, it makes it possible to integrate it with all the enterprises directly involved in the upstream and downstream of SME flows of products, services, finances, and/or information, such as suppliers, logistics service providers, distributors, retailers, and so forth.

4.2. Definition of the conceptual context, perspectives. Literature review and proposals. Proposed theoretical model

To successfully carry out a SCI in an SME, while at the same time reducing the degree of complexity, it would be a great aid to be able to use a stage-based methodology that defines the whole creative process in each phase. This would involve defining, among other things, the tasks to be performed, the techniques to be used, the modelling languages for representing the different domains and the technological infrastructure that allows the supply chain to be integrated.

With a view to solving this problem of a lack of such methodologies for SCI in SMEs, since 2005 the Integration and Re-engineering (IRIS) Group at the Universitat Jaume I in Castellón (Spain) has been working on a research project entitled '*SCI-IRIS: Supply chain integration in SMEs*'. The aim was to develop and validate a methodology, called SCI-IRIS, that adopts a holistic vision to allow a supply chain within an SME to be optimised and integrated. Thirty SMEs from manufacturing sectors participated in the SCI-IRIS research project and were able to benefit from applying the methodology to their supply chains.

An initial version of the methodology was developed based on the literature review together with previous research and practical work on both enterprise integration and SCM in SMEs carried out by members of the IRIS group.

The results obtained by the IRIS group in business integration methodologies were very useful for defining the initial phases of the SCI-IRIS methodology. Thus, the findings accomplished in the integration of an enterprise (Chalmeta *et al.* 2001) and the integration of a network of enterprises that collaborate with one another (Chalmeta and Grangel 2003) made it possible to identify the need for the methodology to include among its different phases aspects such as the planning, the business analysis, the performance

measurement or the business process re-engineering with its connection with human resources and the information system. Later, the experience of the IRIS group in real SCM work in SMEs was used to adapt these phases and to include others, such as supply chain analysis, in the methodology.

In addition, this initial version drew on ideas from other existing methodologies, like those that propose Benchmarking techniques to analyse the environment, those that apply process re-engineering to achieve their integration, or the ones that help to define performance indicators, while always taking into account their adaptation to the specific characteristics of SMEs.

The initial version would then be applied to 30 industrial SMEs with the aim of improving it.

4.3. Identification of the units of analysis. Case selection

The research work was conducted over a period of 18 months. The first task was to select the organisations in which the case study was to be applied. First, contact was established by sending an email to 120 SMEs located in the Valencian Community (Spain), with which our research group had collaborated at some time in the past in different research and innovation projects. The email outlined the aims of the work, the expected benefits that they would gain from taking part in it and the workload that it would represent for the enterprise. After clearing up a number of doubts posed by the enterprises both by email and by phone, the number of SMEs was finally reduced to 55. The criteria underlying the selection of this sample were essentially a willingness to collaborate in the research and the fact that the management of these enterprises were considering (or had at some time considered) improving the efficiency of their supply chain. This first group of 55 SMEs included enterprises belonging to different sectors.

Then, and in accordance with the different approaches to purposive sampling (Patton 1990), the criterion of selecting only industrial SMEs was adopted. Because this resulted in a more homogeneous sample, it was easier to arrange meetings, create templates for gathering data, and so forth, and would later simplify the process of analysing the findings. Nonetheless, within the industrial sector we sought the maximum level of variation among sub-sectors to explore whether the methodology could be useful for any type of industrial enterprise.

As a result of this second selection of companies, the decision was made to work with 30 SMEs that satisfied, in accordance with Yin (1994), all the

requirements that were established in the design of this research. Table 3 presents some of the characteristics of the 30 SMEs participating in the study.

The selected SMEs belonged to the following sectors of industrial activity: manufacture of ceramic tiles (10 SMEs), ancillary industry to the ceramic sector (5 SMEs), manufacture of furniture (5 SMEs), manufacture of textiles (5 SMEs) and the ancillary sector to the automotive industry (component manufacturers) (5 SMEs). Only the ceramic tile enterprises and some of the textile and furniture manufacturing enterprises dominate their supply chain. Moreover, the ancillary industry to the ceramic sector enterprises is the only one with a national supply chain. The other enterprises export part of their products and have international suppliers.

Most of the enterprises analysed, 20 altogether, belong to the segment of small enterprises, with the number of employees ranging from 0 to 50. The other 10 enterprises that were analysed are medium-sized companies with between 51 and 250 workers.

4.4. Definition of research methods and resources

After selecting the 30 SMEs, the fieldwork was prepared and begun. It must be noted that the characteristics of the different organisations were already known to the IRIS Research Group. The group was familiar with the way they were organised, their facilities, their products and services, their technological resources such as websites, and the group already had documentary evidence about them. This prior knowledge about the selected organisations allowed the research to get off on the best possible footing because it meant that important cuts could be made in the time spent on the tasks involving the gathering and analysis of information that have to be performed in any fieldwork.

In addition to the foregoing considerations, to begin the research work, a first meeting was held in each of the organisations. Each of these meetings lasted 90 min and they were attended by all, or nearly all, the department managers and middle management staff who it was thought could be related to the SCI in some way.

The meeting focused on the basic points of SCI and the methodology that was going to be used (initial version of the SCI-IRIS methodology). During the meeting emphasis was placed on the fact that the methodology was structured in phases that were adapted to fit the characteristics of the structure and the resources of SMEs as closely as possible.

Furthermore, to perform all the research tasks during the application of the methodology in each enterprise, mixed work teams were set up with members coming from both the IRIS Research Group and the SCI teams of each of the companies. These SCI teams were made up of either the people in charge of the supply chain activities (when such a department existed in the organisation) or members of staff who had taken part in the initial meeting, when SCM was either not implemented or did not correspond to a particular area. The purpose of the SCI teams was to be responsible for making decisions about all issues related to the work.

In general terms, efforts were made to ensure that the SCI teams consisted of full-time members of staff with some specific weight in the firm and who were familiar with the areas involved in the work. They were also organised in such a way that different components from each department participated in a sporadic but planned manner. Finally, in each organisation one person was appointed as being responsible for all the tasks related with the supply chain.

Later, a second meeting lasting 45 min was held with the organisations' SCI teams to plan the SCI and to begin to apply the initial version of the SCI-IRIS methodology. All the meetings were videotaped and later transcribed so that they could be analysed.

4.5. Fieldwork, data collection, triangulation and classification of information

Once the aims of the research had been presented, data were then collected. This consisted in gathering the results of applying the initial version of the SCI-IRIS methodology in each of the SMEs. The results were collected following the different phases of the methodology using an assortment of questionnaires, templates and models, as well as copies of the documents and reports utilised in the enterprises. The data obtained refer to information about the planning; the situation in which the management of the supply chain currently finds itself, both externally, in relation to the other organisations in the sector, and internally, by searching for critical points in the management of the chain; the design and development of the SCI balanced scorecard; the description of the AS-IS and TO-BE supply chain processes and definition of the proposals for improvement; the creation of job handbooks that state who had to do what, how and with what resources; the requirements of the support information system and the evaluation of available technological solutions; the communication of the aims and the current status of the work; the identification of the

Table 3. Characteristics of the 30 participating SMEs.

Organisation	Industrial activity	Number of employees	Turnover (million €)	Number of suppliers	Number of customers	Position in the SC ^a	Logistics department	Have the CSF and KPI been defined?	Certificates of quality
1	Manufacture of ceramic tiles	130	13.2	350	650	M, D	Yes, 6 people	No	ISO 9001
2	Manufacture of ceramic tiles	150	15	270	430	M	No	No	-
3	Manufacture of ceramic tiles	45	18.5	20	850	D	Yes, 6 people	Yes, partially	ISO 9001, ISO 14001
4	Manufacture of ceramic tiles	30	2	25	11	D	No	No	-
5	Manufacture of ceramic tiles	5	6	3	500	D	No	No	ISO 9001
6	Manufacture of ceramic tiles	160	13	240	400	M	Yes, 4 people	Yes, partially	ISO 9001
7	Manufacture of ceramic tiles	98	14.2	75	225	M	Yes, 12 people	Yes, partially	ISO 9001, ISO 14001
8	Manufacture of ceramic tiles	66	12.3	150	250	M, D	Yes, 3 people	No	-
9	Manufacture of ceramic tiles	39	6.7	>100	>300	M	No	No	-
10	Manufacture of ceramic tiles	35	8.7	250	400	M	No	No	-
11	Ancillary industry to the ceramic sector	18	12.2	35	15	M, D	Yes, 3 people	No	ISO 9001, ISO 14001
12	Ancillary industry to the ceramic sector	32	13.5	35	20	M, D	Yes, 4 people	No	ISO 9001, ISO 14001
13	Ancillary industry to the ceramic sector	22	1.8	20	38	M	No	No	-
14	Ancillary industry to the ceramic sector	12	2	18	34	M	No	No	-
15	Ancillary industry to the ceramic sector	17	3.4	20	43	M	No	No	-
16	Manufacture of furniture	49	3.34	30	200	M	No	No	-
17	Manufacture of furniture	50	6	100	35	M	Yes, 4 people	No	ISO 9001, ISO 14001
18	Manufacture of furniture	37	3.2	46	38	M	No	No	-

(continued)

Table 3. Continued.

Organisation	Industrial activity	Number of employees	Turnover (million €)	Number of suppliers	Number of customers	Position in the SC ^a	Logistics department	Have the CSF and KPI been defined?	Certificates of quality
19	Manufacture of furniture	87	8.3	78	27	M	Yes, 4 people	Yes, partially	ISO 9001, ISO 14001
20	Manufacture of furniture	54	5.7	44	57	M	No	No	-
21	Manufacture of textiles	36	2.3	30	46	M	No	No	-
22	Manufacture of textiles	42	2.7	32	42	M	No	No	-
23	Manufacture of textiles	53	3.1	32	53	M	Yes, 2 people	No	ISO 9001
24	Manufacture of textiles	50	3.4	28	48	M	Yes, 5 people	Yes, partially	ISO 9001
25	Manufacture of textiles	38	2.8	26	46	M	No	No	-
26	Ancillary sector to the automotive industry	63	8.4	32	6	M	Yes, 8 people	Yes, partially	ISO 9001, ISO 14001
27	Ancillary sector to the automotive industry	60	8	38	8	M	Yes, 6 people	Yes, partially	ISO 9001, ISO 14001, OHSAS 18001
28	Ancillary sector to the automotive industry	32	6.7	25	6	M	Yes, 3 people	Yes, partially	ISO 9001, ISO 14001
29	Ancillary sector to the automotive industry	43	6.9	43	9	M	Yes, 4 people	Yes, partially	ISO 9001, ISO 14001
30	Ancillary sector to the automotive industry	40	9	27	6	M	Yes, 7 people	Yes, partially	ISO 9001, ISO 14001, OHSAS 18001

Notes: ^aPosition in the supply chain: M, manufacturer; S, supplier; C, customer and D, distributor.

benefits gained; and the comments and suggestions about the methodological procedure that was followed.

The next step was to structure and classify the different suggestions for improving the SCI-IRIS methodology for the SCI proposed by each of the mixed work groups as a result of their experience.

Following recommendations put forward by Yin (1998), multiple data sources and, therefore, compliance with the principle of triangulation were chosen to ensure the research could be replicated theoretically. This made it possible to verify whether the data obtained from applications to different companies were related to one another, that is to say, whether the effects explored were in line with the aim of the research when the initial version of the SCI-IRIS methodology was applied to the cases under analysis. In this case study, two triangulation types were considered: *spatial triangulation of data* (three sources of data were considered: observation, interviews and documentation); *personal triangulation of data* (all the people in charge of the supply chain activities from each enterprise were interviewed to obtain information from each of them).

4.6. Formulation of the improved SCI-IRIS methodology

Once the improvements observed in each enterprise had been identified, different meetings were arranged with the representatives from all the companies to agree on the improvements that had been identified as necessary and implement them in the final SCI-IRIS methodology. It should be noted that agreements were reached relatively quickly.

The methodology that was finally obtained (SCI-IRIS) is divided into nine phases:

- (I) SCI planning.
- (II) Analysis of the business.
- (III) Analysis of the supply chain.
- (IV) Designing the balanced scorecard of the supply chain.
- (V) Process redesign.
- (VI) Organisation and management of human resources.
- (VII) Construction of the information system.
- (VIII) Implementation.
- (IX) Continuous improvement.

These phases are not independent and must generally be implemented sequentially. The relation between the different phases can be seen in Figure 1. In addition, Table 4 presents a summary of the aims and

techniques that were used in each phase of the methodology.

4.6.1. Phase I: SCI planning

In the first phase it is necessary to establish the scope of the SCI, specific aims and mechanisms of control. Thus, the first task to be performed is to specify what the SCI is to achieve by establishing a set of goals that are clear but attainable with the resources that are either already available or can be obtained.

The second task to be addressed is the commitment of management. To achieve this, it is necessary to get both management and its steering committee totally involved so that they see the SCI as their own and are willing to act with conviction when possible deviations arise. To carry out this process of change successfully, there must be a proactive attitude towards it at the management level so that it is these same executives who transmit the virtues of the process of change within the different areas they are in charge of. To ensure that no area is left unaided, this will be the right time to review the different responsibilities within the organisational structure of the enterprise.

Once the commitment of management has been obtained, it is necessary to set up the work team, which will be directed by a coordinator chosen from among the persons with the greatest specific weight and experience inside the SME. This coordinator will answer directly to management and carry out tasks involving following up and coordinating the different work teams made up of skilled members of staff from each of the areas in the company.

Finally, in this first phase it is necessary to define the mechanisms that will be used to communicate the evolution of the SCI work. This will involve structuring what information is to be given to each level of the SME and how it is to get there, possible mechanisms being internal mail, informative meetings or bulletin boards.

During this phase, it is necessary to create the plan for the SCI and to implement it in a project management software application, to establish the quality control mechanisms and to draw up the plan for change. The owners of the SME must allow its members to take part in the definition of the SCI work.

4.6.2. Phase II: analysis of the business

The starting point within any management programme is always an analysis of the firm's objectives (mission, vision and strategy) and of its culture (policy and values). This is why it is essential, before beginning any SCI work, to understand and make the SME's strategy

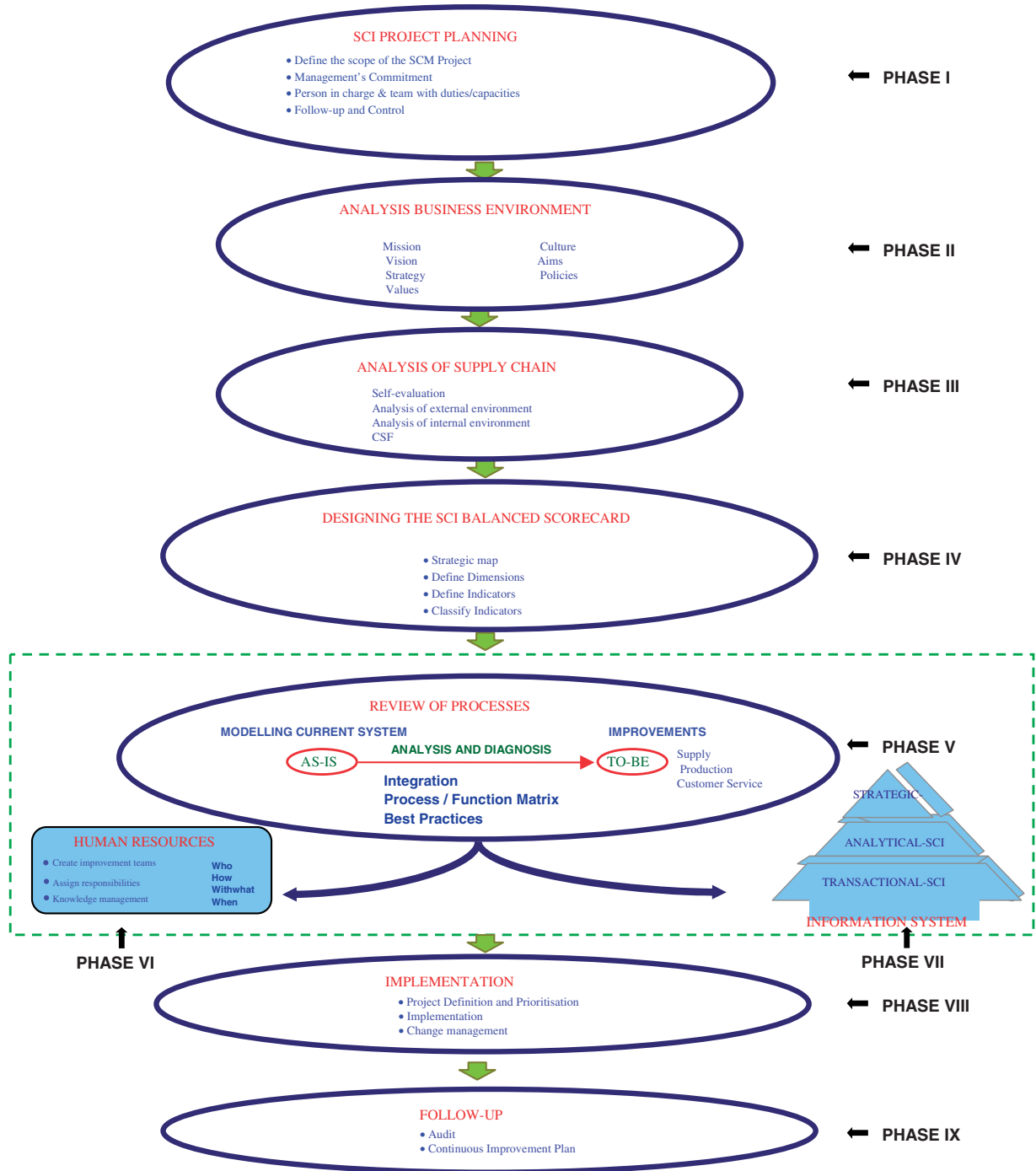


Figure 1. Diagram of the stages of the SCI-IRIS methodology.

explicit by defining where the firm stands, where it wants to go and where it is actually going, as well as to analyse its culture, level of organisation and internal control.

To be able to carry out these tasks it is essential to have access to tools that, in the case of SMEs, must be of proven worth and simple to use. In the SCI-IRIS

methodology, the model used to analyse the competitive environment of SMEs is the five forces model (Porter 1980). On the other hand the model used to identify the influence of the political, economic, social, technological, ecological and legal factors on the environment surrounding SMEs in supply chain is the PESTEL model (Johnson and Scholes 2002). This

Table 4. Summary of the Activities, Aims and Techniques used in the SCI-IRIS Methodology.

Phase	Activity	Objectives	Techniques/Tools
I. SCI planning	Definition of the goals of the SCI	Commitment by management	Presentation meeting with management
	Definition of resources	Allocation of resources to the SCI	Loads/availability
	Organisation of SCI	Define those in charge and teams	Project management software
	Definition of communication, monitoring and control mechanisms	Involvement of the organisation members in the SCI	periodic meetings, notice boards, etc.
II. Analysis of the business environment	Definition of business goals and culture	Formal definition of: mission, vision, values and strategies	Management meetings
	Analysis of the SME environment	SME sectoral analysis	PESTEL model Five forces model (Porter 1980)
		Positioning of SME	SWOT matrix (applied at the sectoral level)
III. Analysis of the supply chain	Self-evaluation of the SCM	Verify the situation of the SC	Internal questionnaire SC
	Analysis of the external environment of the SC	Opportunities and threats implications possible actions taken	Identification of best practices Benchmarking SWOT matrix
	Analysis of the internal environment of the SC	Strengths and weaknesses Implications Possible actions taken	SWOT matrix
	CSF	Identification of CSF classification and prioritisation of CSF	CSF template Decision and prioritisation matrices
IV. Designing the SCI balanced scorecard	Determination of the work dimension of the indicators: – Management dimension – Logistic process/area dimension – Attribute dimension	Selection of the work dimension from the indicators according to the organisation's needs	SCI balanced scorecard
	Production of the strategic map	Locate and relate CSF	
	Identification of the KPIs	Identification according to the dimension that is sought	
	Formulation of the KPIs	Specification of each indicator	
	Classification of the Indicators by dimension	Locate KPIs	
	Follow-up of the cause-and-effect strategic map	Correct deviations	Follow-up meetings
	Definition of goals	Levels of performance	Evaluation meetings
V. Review of processes	Internal and inter-organisational process modelling	Description of work processes (AS-IS): – Tasks	– IDEF0 modelling (what)

(continued)

Table 4. Continued.

Phase	Activity	Objectives	Techniques/Tools
		– Resources (Human and Technical)	– RAD (Role Activity Diagram) (who, where)
		– Relations	
	Integrate internal and inter-organisational processes	Process map (AS-IS)	Processes/functions matrix
	Diagnosis and proposal for improvements	Verify initial situation	Positioning study self-diagnosis by EFQM modelling
		Review and analysis of existing processes	Benchmarking
		Process map (TO-BE)	Best practices (external)
		Contingency diagram (actions/people responsible)	Own practices (internal)
		Management of identified misalignments	– IDEF0 Modelling (what)
			– RAD (Role Activity Diagram) (who, where)
			GAP analysis meetings
VI. Human resources	Change management	Training: cohesion process, skills development plan	Awareness-raising meetings
	Define jobs, tasks and responsibilities (who, what, where and how)	Production of job handbooks	Training courses
	Creation of teams for improving the SCI	Definition of members and responsibilities implementation of improvements	Templates for defining jobs
	Creation of the programme of training schemes	Training of management	Assignment meetings
		Training of shop-floor workers	Six Sigma methodology
		Training of different teams	
VII. Information systems	Design of information system	Define requirements catalogue: general, technical and functional specifications	Software development models
	Allocation of human and technical resources	Define development teams	Methodology for computer software development
	Design the system architecture	– Analysis	
		– Design	
		– Programming	
	Plan for testing the interface with the previous IS	Definition of prototypes	
	Utilisation control and management	Define procedures to control access, operation and administration of the system	
	IS Training schemes	Training of users	Training courses
VIII. Implementation	Total quality plan	Quality assurance and control	ISO 9000 Communication plan

(continued)

Table 4. Continued.

Phase	Activity	Objectives	Techniques/Tools
IX. Continuous improvement	Compare the present and future situations	Training of implementation teams Identify restraints and proposals for improvement	AS-IS, TO-BE, GAPS templates
	Migration plan	Planning and responsibilities – Feasibility study – Prioritise proposals for improvement	Project management Software Cost/efficiency approach models
	Monitoring the implementation. Control and improvement teams	Control of deviations over time Prevent resistance to change/motivation Measure the degree of participation Evaluation of results Monitoring indicators	Follow-up and control meetings
	Quality assurance	Meet ISO 9000 requirements	ISO 9000 model
	Continuous improvement	Periodic review Management of improvements that are identified	Continuous improvement meetings Application of continuous improvement techniques

model allows a formalised appraisal of the context within which the supply chain operates and it is mainly useful in complex supply chain (Christopher and Peck 2004). The practical application of a PESTEL model must be carried out through one or several brainstorming sessions attended by the components of the work team. At these meetings, which should not last more than 30 min, each of the members of the team will have to first generate new ideas about one of the influencing factors of the model. Then, the work team will have to evaluate all the ideas that have been put forward and choose the most representative ones.

The second task in this stage will be to redefine (or if it already exists, to make clear) the general strategy of the SME, which will state the way in which the processes are going to be carried out, as well as how the company's resources are going to be managed to reach the goals that have been set.

To define the business strategy, it is necessary to perform an in-depth analysis of the opportunities and threats that exist in the market, together with the strengths and weaknesses inherent to the organisation itself and all of this must be represented in a SWOT (strengths, weaknesses, opportunities and threats) matrix. Elements such as market research, management of the firm's technical, human, economic and

financial resources, planning and communication are essential to carry out the business strategy properly. To define the SWOT matrix, it will be necessary to arrange a series of meetings similar to those held in the PESTEL analysis. The results of the analysis of the strengths and weaknesses performed using the SWOT matrix make it possible to identify the fundamental strategic goals that the SMEs have to be able to achieve their mission and vision. The analysis of their opportunities and threats enables us to identify the positive and negative aspects (respectively) of the sectoral environment that may or may not help them accomplish their mission and vision.

For the SME, clarifying its strategy correctly will have a positive effect on its future, as this will help to make up for the shortage of human and financial resources.

4.6.3. Phase III: analysis of the supply chain

The purpose of this phase is to analyse the situation in which the SCM currently finds itself, both externally (in relation to the other firms in the sector) and internally, by searching for the critical points in the management of the chain within the organisation itself.

To do so, the analysis can be started by taking the best practices of leading SMEs in the sector as an example, while always bearing in mind the particularities of the different supply chains and their corresponding work environments.

Once the best practices that fit the particularities of the SME have been identified, it is advisable to reach an agreement with the other management staff in the organisation on complying with them, since this will provide an initial view of the situation of the organisation.

The next step will be to use the SWOT methodology, but restricting its scope of application to the supply chain to detect critical points in its management.

(1) Analysis of the external environment of the supply chain:

This analysis must focus on analysing the supply chain in the sectoral environment to search for possible business opportunities and threats (either existing or new) thanks to a novel utilisation of information technologies, the appearance of potential customers, changes in customers' habits, and so forth. These opportunities and threats can be detected by resorting to different sources of information, which may be private or public, in the form of reports from Chambers of Commerce, Universities or sectoral studies, and so on. Once the main strengths and weaknesses have been identified, the next step is to evaluate them to determine the extent to which they affect the supply chain.

(2) Analysis of the internal environment of the supply chain:

This analysis, unlike the previous one, will have to examine the supply chain from the SME's point of view, by analysing the strengths and weaknesses that exist in the whole internal work environment, but also by extending outwards so as to cover the relations with suppliers and customers. The aim is to perform a critical review of the performance of the processes and interactions among the components of the supply chain by posing a series of questions so that a process of reflection can be undertaken among all the members of the SME. This analysis will make it possible to establish a preliminary set of the main strong and weak points in the work procedures.

To finish this phase of the analysis of the supply chain, it will be necessary to identify and later classify the critical success factors (CSF), which are the factors that the SME must focus on if it is to satisfy its suppliers' and customers' needs as effectively as possible. In sum, to identify them, the firm must ask itself

questions like: *What are the things, aspects, areas or activities in my supply chain that I cannot fail in because if I did, it would make it impossible to reach our goals and lead us away from fulfilling our mission?* The analysis of these factors will allow them to identify the actions with the highest priority among all the possible actions that can be included in the Action Plan.

4.6.4. Phase IV: designing the SCI balanced scorecard

The aim of this phase is to design a balanced scorecard for managing the supply chain by identifying and classifying the KPIs that will make it possible to evaluate and control the objectives set for the supply chain and to do so in a structured and effective way (Hudson and Smith 2006).

Balanced scorecards are traditionally structured on the grounds of the four classical perspectives defined by Kaplan and Norton (1996), but some authors such as Andersen *et al.* (2001) and Manville (2007) question the validity of their application for SMEs, pointing out that there is currently a gap in the literature regarding the implementation of BSC solutions in SMEs. Thus, the research conducted by Hudson *et al.* (2001a) and Turner *et al.* (2005) concluded that SMEs can see the value of a performance measurement system but add that there are significant barriers to its implementation due to resource issues, the fact that it may be too strategically orientated and the difficulty involved in identifying KPIs.

In the initial version of the SCI-IRIS methodology the traditional four-perspective structure was followed. It was later found, however, that this approach was rejected by the different teams in the SMEs because they came up against many problems to define the strategic map when they tried to place the strategic goals into classical perspectives. In the end, and after analysing the different alternatives generated by the mixed work teams, the final version of the SCI-IRIS methodology proposes arranging the indicators in three new dimensions of work. This approach provided those in charge in each organisation with a simple way to identify the indicators that were best suited to the required level of management.

This phase is thus divided into three stages:

(1) Producing the strategy map

As the basis for designing the balanced scorecard, first what is known as a strategic map must be produced and this requires a thorough analysis by management of all the goals that are to be reached, the relationships among them, and their time frame, with priority given to those goals that can help

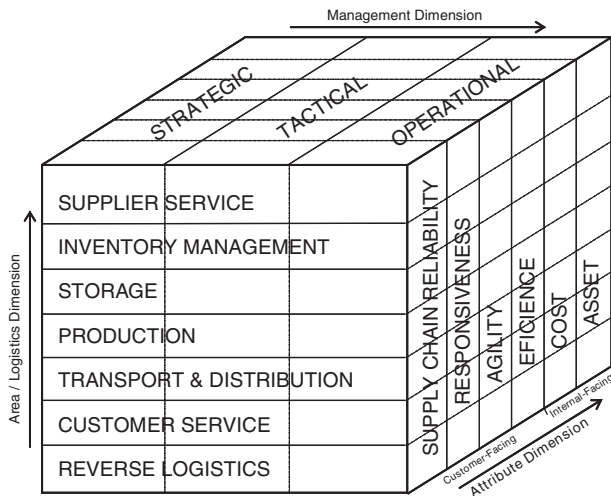


Figure 2. Work dimensions of the indicators.

overcome the barriers that prevent SCI from being carried out. Moreover, continuous checks must be made to ensure the goals are actually in tune with the strategy.

(2) Determination of the work dimension of the indicators

This section proposes that, as a task to be carried out prior to identifying the indicators, the management of the firm should analyse the level the enterprise is to work at and whether it has the resources necessary to do so. To this end there are three possible work dimensions of the indicators, which are alternatives that each company can combine to suit its own needs. These three work dimensions of the indicators are as follows (see Figure 2):

(I) Management dimension

This is the name given to the structuring of the indicators according to the decision level of the goals. It follows the classical model of management in organisations, i.e. strategic, tactical and operational.

(II) Logistic process or area dimension

At this level the indicators are classified according to the logistic process or area they are going to work in. This is perhaps the simplest classification when it comes to applying it in any enterprise. Management in the firm can detect the indicators in each case by going straight to the persons who work in the area in question every day and asking them for the information that is needed. These workers are thoroughly familiarised with the functioning and mechanisms available in their area and are, therefore, in a position

to identify, define and quantify a suitable set of indicators.

The areas that are suggested in this dimension are as follows, although each SME must adapt them to meet its own particular characteristics: supplier service, inventory management, warehousing, production, transport and distribution, customer service and reverse logistics.

(III) Attribute dimension

This third level involves classifying the indicators according to six attributes that can be organised in two different perspectives: from the external, or customer's, point of view and from the internal point of view. This last classification dimension is based on the SCOR methodology, but is extended by including the efficiency attribute. The classification attributes are as follows:

- Customer perspective
- Reliability. This measures the correct performance of the tasks in the supply chain.
- Responsiveness. This measures the speed at which the supply chain delivers products to its customers (whether internal or external).
- Flexibility. This measures the way the supply chain responds to changes in the market to gain or maintain its competitive advantage.
- Efficiency. This measures the rational use of the resources available to achieve a particular goal.
- Internal perspective
- Cost. This measures the cost associated with the management of the supply chain itself.
- Management assets. This measures the efficiency with which the organisation manages the assets that support the demand requirements.

(3) Identification of the indicators

Once we have defined the highest or lowest level of aggregation on which the enterprise wishes to work in each dimension, to follow-up the goals set in the strategic map, the next step will be to identify suitable indicators for assessing and controlling those goals. Only indicators that measure the scope of the goals defined in the strategic map should be included, they must be expressed quantitatively and it must be easy for the organisation to understand their meaning.

One of the main advantages of structuring the indicators in different dimensions like this will prove to be very useful during the process of following up the goals, since it will have made it possible to assign the

control of each of the indicators to the area that is best suited to doing so.

The last point in designing the BSC will be to produce, in each of the dimensions under consideration, a diagram of the causes and effects among the indicators so as to define the paths to be followed to achieve them. These cause-effect links will also serve as an effective diagnostic tool.

4.6.5. Phase V: process redesign

Once the organisational framework, the supply chain objectives and the indicators have been defined, the next step is similar to a business re-engineering. It involves redesigning the business processes of the company's supply chain to achieve the objectives that have been previously defined and to improve customer satisfaction and loyalty. It is important to point out that the aim is not for SMEs to study and computerise their current way of working, but to take advantage of the possibilities of the new information technologies to redesign and improve their processes involving the supply chain.

To build this new process map, it is necessary to (1) analyse the current situation (AS-IS model) by means of questionnaires and interviews with company staff and (2) design what the company's supply chain processes should be like in the future, that is to say, the TO-BE model.

The limited resources that exist in SMEs make it necessary to determine the key internal and inter-organisational processes for the success of the SCI work, so as to be able to act upon them. Once they have been identified, the improvement process is carried out in four stages: process modelling, redesign, feasibility analysis and implementation of the improvement plan. The map of processes must include specification of the following aspects:

- Name and description of the process.
- Type of process (support/customer).
- Inputs and outputs.
- Process diagram showing the sequence of activities.
- Indicators for evaluating the process.
- CSF of the process.
- Plan of improvements to the process.

Some authors suggest that in redesigning business processes it is necessary to forget the AS-IS and to focus on the ideal operational model when it comes to designing the TO-BE. However, the IRIS group's experience in carrying out business process redesign and improvement at various enterprises shows that the existing means (human and technological resources,

and so forth), as well as the company's culture and psychology, are a great restriction. Hence, when it comes to defining the business processes for the TO-BE, it is necessary to understand the AS-IS and choose the best realistic solution rather than suggesting ideal ones.

Developing business process models is a very useful way to understand the AS-IS and to represent improvements in the processes (the TO-BE). Different graphic representation techniques can be used to model AS-IS/TO-BE business processes (Chris 1999). Our experience in real business process redesign projects (Chalmeta *et al.* 2001) leads us to conclude that one of the best solutions for modelling AS-IS/TO-BE business processes is IDEF0 (CAM-I 1981). This is due to the fact that an IDEF0 model includes the most important aspects needed to understand the functioning of a process and the proposed improvements, but can nevertheless be understood by the members of staff at the enterprise who are not specialised in the use of models and have to use them and validate them. The weak point of IDEF0 is that it is static. Therefore, in complex processes in which the user is interested in simulating their behaviour over time (such as analysing bottlenecks, as would be the case in productive processes), the initial IDEF0 modelling can be completed with other modelling languages such as IDEF3, Petri Net, and so forth, which can be executed later on a computer. In our opinion, however, from a practical point of view it is more useful to model and simulate these processes with a commercial simulation software application.

A number of different tools can be used for identifying improvements in the SME's business processes. The most important are the knowledge and skill of the employees responsible for carrying out the redesign, the experience of the workers involved in the day-to-day execution of the process, the use of specialised consulting firms or comparison with other enterprises. For this last case it is very useful to have a reference model with best working practices. Models with practical improvements may be either general (that is, valid for any company) or sectoral. General models are not very detailed and, consequently, their use is rather limited in business process redesign. This is mainly because the reference models require a high level of detail and depth if they are to be useful in business process redesign. The reason for this is that all the activities in the process have to be identified, together with the inputs and outputs (information and materials), resources and controls. Thus, having access to a detailed sectoral model is very useful in such cases.

Furthermore, once the improvements to the process have been defined, they must be validated and they

must be presented to the other components of the organisation. In this process, the tasks that have been defined in the new functional design must be shown to each of the areas involved. The aim of this is to seek the agreement and approval of the members of the organisation that are actually going to carry them out in their day-to-day commitments or, if necessary, to reconsider any issues that would not be feasible. Meetings shall continue to be held until all the aspects underlying the TO-BE model have been accepted by the organisation.

Finally, once the improvements have been validated to evaluate their cost-effectiveness and put them in order of priority (since resources are scarce – and more so in the case of SMEs), a feasibility analysis must be performed. Traditional cost/benefits analysis is a very useful tool to define the priority of the improvements. However, organisational, technical and operational aspects should also be considered.

4.6.6. Phase VI: human resources

The people in a company are the key to any business strategy. This is the part that determines SCI success or failure and cannot be underestimated (Yee *et al.* 2008). Therefore, the aim of this phase is to ensure all members of the organisation are familiar with the SCI work, and to be able to allay their fears, concerns and doubts before it is implemented. They must understand the importance of SCI but, above all, they have to receive instruction on this new philosophy of integral management. The aim is to create a corporative culture in which its tasks are always approached taking into account the needs of suppliers and customers in each process.

This change in the corporative culture is not a single step in the SCI process and the main challenges involved are: to change the traditional culture focused on the individual short-term outcomes, which contradicts the vision of the SCI that seeks to achieve high performance and sustainable profitability in a way that benefits all contributors in the supply chain; to prevent decisions from being taken in isolation by weighing up the consequences in all the enterprises and departments involved; to bring about a change in the staff working in the organisation by pursuing a more participative style of management and by introducing the concept of continuous improvement into their activities; and to foster the creation of new and better relations among enterprises.

To overcome these challenges, both management and employees must understand and accept the strategic business value of the SCI. These key participants must realise that SCI is not just a technological

strategy, but rather a business strategy that is essential to the success of the individual departments and the organisation as a whole. Only the commitment and support of both management and employees will make it possible to undertake the SCI and to share information efficiently throughout the entire supply chain.

The SCI will change the job roles and the organisational chart, since work teams will be set up with members of staff from different departments, such as marketing, warehousing, production, distribution, and so forth. This is a less hierarchical type of organisation (rather like process management) and this change must be set out in a handbook which contains descriptions of the different job profiles, the activities they must each perform, how they are to be done and with what resources.

Moreover, to manage this process of change, the human resources area will have to arrange awareness-raising and skill-development meetings. On the other hand, an integrated training plan for all levels of the organisation must be addressed, with the backing of management.

4.6.7. Phase VII: information system

to achieve real implementation of the SCI it is essential to have appropriate information and communication technology (ICT) that provides the information needed to coordinate, manage, operate and control the supply chain (Boone and Ganeshan 2007). In this phase of the SCI work, the SME will have to design that information and communications infrastructure. To do so, it will have to take the following aspects into account, among others:

- Definition of the hardware and software elements that will allow access to the technological infrastructure, and development of suitable converters.
- Establish a security system to ensure the quality, security and authenticity of the information about the users that access the infrastructure.
- Interoperability with the information systems of the different enterprises and organisations that belong to the supply chain.
- Integration of the computer system that automates the flows of information associated with the different business processes of the SME that are related to the supply chain.
- Development of a computer application to support the BSC that was defined in Phase III of the SCI-IRIS methodology.

AREA:	Logistics	DOCUMENT CODE :	As-is/To-be	FILE:	XXX
MACROPROCESS :	Management stocks	AUTHOR:	XXX		
MICROPROCESS :	Product arrival	CREATION DATE :	XXX	MODIFIED DATE :	XX

ACTIVITY ⁽¹⁾	AS – IS ⁽²⁾	TO – BE ⁽³⁾	FIT ⁽⁴⁾	GAP + Restrictions ⁽⁵⁾
1.				
2.				

Figure 3. Example of a template for the AS-IS/TO-BE analysis.

Notes: (1) The activity row must show the activities of the inter-enterprise business process model. (2) Describes how the activity is carried out in the present. (3) Describes how the activity must be carried out in the future. (4) Should indicate: OK: if the activity is carried out at present in a desirable manner. NOT OK: if the activity is not carried out in a desirable way. (5) Describes the differences between the TO-BE and the AS-IS, showing possible restrictions to go from the AS-IS to the TO-BE.

Finally, and once the importance of the information systems for the management of the supply chain has been acknowledged, firms must accept the fact that these systems are of no use whatsoever if the information that feeds them is not updated, if it is incorrect or if it does not flow quickly and accurately among the different links in the chain. It is thus essential that the area to be managed with the new information system should draw up a training plan, in coordination with human resources, for all the users of the new system.

4.6.8. Phase VIII: implementation

The next stage within the SCI-IRIS methodology concerns a total quality plan and consists in implementing and controlling the migration from the old system (AS-IS) to the new one (TO-BE). Figure 3 shows an example of a template for managing the AS-IS/TO-BE analysis. The column entitled GAP + restrictions shows the differences between the current way of working, the new proposal and the restrictions that exist for moving from the current to the future situation. Hence, the implementation plan can be broken down into a set of feasible proposals for improvement according to the financial and physical capacity of the enterprise.

Proposals for improvement can be arranged in order of priority, according to a viability study, and will make up the transition from AS-IS to TO-BE. Once they have been prioritised, the short-term proposals for improvement must be implemented. This will involve changing attitudes, both among

management staff and among shop-floor workers, defining new work roles for each position, and redesigning the company’s organisational chart. The outcome of this must be that everyone in the company has their duties assigned to them, as well as knowing what they must do and how to do it. Management of all the projected changes must be carried out by implementing control mechanisms similar to those used in the ISO-9000 Standard.

Adequate management of the change is essential in this section. It is common for the executives of an organisation to see that the organisation clearly needs to change, but they are unable to do so correctly because they invest a great deal of time and knowledge in developing the plan but very little time in how to get the organisation to implement, commit itself to and develop that change. To increase the chances of success, it is necessary to: (1) develop a plan of communication which reflects the final vision of the SCI work and communicates it, and (2) set up work teams that are responsible for the change and transmit it throughout the whole organisation by acting as catalysts. In this team, it is necessary to define exactly what its duties and responsibilities will be, who its members will be, what each of them will do, who its leader will be and how often meetings are to be held.

4.6.9. Phase IX: continuous improvement

Finally, it is necessary to construct a system of continuous improvement that allows: (1) the proposals for improvement that have been classed as medium

and long term to be implemented in the future, while at the same time and (2) adapting the company to the changes that may come about in its surroundings. When these proposals for improvement have been carried out, implementation of the SCI is complete.

While the SCI is being implemented, it is essential to define the monitoring, control and continuous improvement teams so as to be able to manage the deviations that are detected, to perform a follow-up of the indicators that were defined in the initial stage of managing the SCI, as well as to act appropriately to correct any deviations that may have arisen. Furthermore, these groups will act as catalysts in the presence of possible resistance to the process of SCI.

4.7. Verification of the rigour and quality of the study

As a final step in the application of the case study to enhance the SCI-IRIS methodology, the results were analysed to check their validity and degree of confidence. To do so, the different models existing in the literature on management were reviewed and the model developed by Yin (1998) was finally chosen for use. This model is based on the verification of four tests to ensure the reliability and consistency of research based on case studies. These tests proposed by Yin are as follows: constructive, internal and external validity, and the reliability test. In carrying out this research, each of these tests was checked to ensure they were being fulfilled, since the works were carried out in strict compliance with the phases defined by the proposed methodological design of the case study and by both theoretical and methodological triangulation, and triangulation of data. Moreover, systematic critical comparison was performed among the structured propositions from the theoretical reference model and those obtained from sources of evidence, to which replicating logic (multiple case studies) was applied to achieve analytical generalisation. The validity and quality of the study that was carried out can thus be confirmed.

5. Significant benefits noted by participating SMEs

One of the interesting aspects of the research work was to see how the application of the methodology in the 30 enterprises made it possible to overcome most of the barriers detected in the SMEs that prevented them from integrating their supply chains and obtaining some of the potential benefits listed in Section 3.

The benefits observed were identified 4 months after finishing the application of the SCI-IRIS

methodology and, thus, the new organisational structures had been assimilated by the SMEs and the new management software had been implemented. To this end, a qualitative survey was prepared in which each of the people responsible for applying the SCI-IRIS methodology in the enterprise were given a questionnaire that included the 16 potential benefits presented in Table 1. Three possible answers were offered for each of the benefits and they had to choose the one that best fitted their perception of the extent to which the benefit had been accomplished. The three options were the following: the benefit really had been accomplished, the benefit had not been obtained and an intermediate answer if it was not absolutely clear whether it had been achieved or not. A space was also provided in case an SME identified a new benefit, although none of them did so. The analysis of the results obtained in the questionnaires can be seen in Table 5, which shows the percentage of SMEs that said that a benefit really had been accomplished. No distinction was made between sub-sectors.

It is important to note that of the 16 potential benefits, four of them were identified as having really been accomplished by a very small number of enterprises. These potential benefits are: lower the cost of labour, cost of new product developments, product innovation lead time and increased access to financial support. One possible explanation for the low rate of accomplishment may be the fact that the SCI-IRIS methodology was only implemented a short time ago.

Other important results are the KPIs defined by the companies taking part in the project for each of the dimensions (Table 6 presents some of them). They can be used as a database of reference indicators organised according the SCI balanced scorecard. This could be a fundamental aid for defining the SCI indicators of a particular SME, since such enterprises do not possess any previous skills that enable them to identify and specify such indicators.

6. Conclusions

The literature review indicates that SCI is a competitive business approach for SMEs that, in practical terms, is not being carried out as often as expected. This is a consequence of a number of different factors, such as the absence of a methodology allowing SMEs to undertake all the tasks needed to reach SCI without neglecting their particular characteristics.

To be able to carry out the integration of the supply chain within SMEs, the SCI-IRIS methodology was defined. To do so, an initial methodology was drawn up and applied to 30 SMEs, and later refined. The

Table 5. Significant benefits observed by the SMEs.

Significant benefits observed	Observed (%)
• <i>Generation of proactivity with regard to the process of SCI.</i>	100
• <i>Further performance improvements</i> by defining a KPI identification model that fits the characteristics of the way an SME works and agrees with its management needs.	93.3
• <i>Integration of tasks and shared information</i> on the different levels of the supply chain.	91.64
• <i>Collaboration and coordination of all the components of the supply chain</i> to allow joint action plans to be designed and carried out, so as to obtain coherent and synchronised planning that responds promptly to market variations.	91.09
• <i>Improvements in inventory management.</i> Online information about supplies in warehouses made it possible to forecast production needs and to optimise stock management.	89.94
• <i>Programming and follow-up</i> of supply delivery dates, production times, and delivery times to end customers, which ensures a greater capacity to react in order to cope with market demand.	89.93
• <i>Significant improvements in both customer and supplier services</i> , because knowing the status of orders and creating synergies among them makes it possible to reduce all delivery times.	87.64
• Sales, purchases, warehousing and production departments can <i>share and process information simultaneously</i> . Thus, members of sales staff will be able to provide customers with accurate information about product availability; warehouse staff can search for products quickly and simply; purchasing personnel have access to accurate real-time data so that optimal levels of stock can be maintained and stock maintenance costs can be minimised, and so forth.	87.43
• <i>Clear improvements in the productivity of the operational logistics system</i> , which increased the levels of customer service and made it possible to carry out actions that led to better administration of operations and to the development of lasting relationships that were highly beneficial to key suppliers and customers in their supply chain.	86.98
• <i>Generation of a coordinated work flow</i> to ensure the different areas of the components of the chain work properly.	86.59
• <i>Cutting costs.</i> Integration of the supply chain allowed a drastic reduction in operating costs to be achieved.	84.39
• <i>Generate and identify new business opportunities</i> which had previously either gone undetected in each company or had not been detected because there was no collaboration among the partners in the chain.	80
• <i>Lower the cost of labour</i>	19
• <i>Cost of new product development</i>	16.6
• <i>Product innovation lead time</i>	13.3
• <i>Increase access to financial support</i>	11

results obtained show that this step-by-step methodology enables SMEs to overcome the barriers that prevent them from achieving a correct integration of their supply chains and obtaining most of the significant benefits of SCI in SMEs reported in the literature.

Proposing a methodology like SCI-IRIS is an innovation in this field of research, since similar works based on case studies, such as the one by Chen *et al.* (2004), focus on analysing different aspects of SCI in SMEs, like benefits, degree of integration achieved, obstacles hindering its implementation, and so forth, but none of them propose a methodology.

Hence, the findings obtained are useful for the management staff of SMEs, since they can offer them some guidance on the potential benefits to be obtained from the integration of their supply chains. They may also provide solutions to a number of hidden organisational problems and which become apparent during the integration process. Another interesting conclusion from the application point of view is the

structure proposed in the methodology for defining and assigning KPIs to the areas of responsibility that must work with them. Throughout this study this approach has proved to be wholly valid for the case of SMEs.

Within the academic field, the main contribution of this research lies in the fact that it has confirmed that the barriers preventing the integration of the supply chains in SMEs can be overcome if this integration is implemented by means of the SCI-IRIS methodology. Additionally, a solution to the problem of applying the BSC to SMEs described by authors such as Hudson *et al.* (2001b) has also been presented. This solution involves defining new dimensions of work for identifying and classifying KPIs.

Finally, it is important to discuss the limitations of the study and future prospects of the research. On the one hand, the limitations of this study are essentially concerned with the research method. Because it is a case study focused on a limited set of enterprises from the industrial sector, the validity of the methodology

Table 6. Some KPIs identified in the case study.

Area or logistic process	Attributes					
	Customers' perspective			Internal perspective		
	Reliability	Capacity to respond	Flexibility	Efficiency	Cost	Management assets
Suppliers' service	<ul style="list-style-type: none"> Percentage of errors in customers' orders. (O) Complete and on-time deliveries. (O) Level of purchaser – supplier relationship. (S) 	<ul style="list-style-type: none"> Time for processing customers' orders. (O) 	<ul style="list-style-type: none"> unforeseen increase in orders. (T) 	<ul style="list-style-type: none"> Orders to supplier processed per person. (O) Quality of delivery on receipt. (T) 	<ul style="list-style-type: none"> Inventory rotation. (S) Costs of Raw Materials over Sales. (S) Inventory management cost. (O) 	<ul style="list-style-type: none"> Cash-to-Cash Cycle Time, that is, the time elapsed between paying suppliers and receiving payment from customers. (S) Return on capital invested in Supply Chain assets. (S) Return on Work Capital. Investment in work versus income generated by the chain. (S) Total Cash Flow time. (S) Return on investments ratio. (S)
Inventory management	<ul style="list-style-type: none"> Forecast accuracy. (T) Percentage of inventory accuracy. (T) 			<ul style="list-style-type: none"> Level of service. (S/T) Validity of the methods for planning and predicting demand. (T) 	<ul style="list-style-type: none"> Total cost of self-management of the components in the supply chain. (S) 	<ul style="list-style-type: none"> Information management cost. (O)
Warehousing	<ul style="list-style-type: none"> Error percentage in materials picking. (O) 	<ul style="list-style-type: none"> Units moved per man-hour. (O) Picking units per hour. (O) 	<ul style="list-style-type: none"> Flexibility of the chain to cope with an increase/decrease in market demand. (S) 	<ul style="list-style-type: none"> Percentage of utilisation of warehouse capacity. (S/T) 	<ul style="list-style-type: none"> Reprocess time. (T) Operations performance. (T) Total cost of self-management of the components in the supply chain. (S) Manufacturing cost. (O) 	
Production	<ul style="list-style-type: none"> Number of Non-conformities. (O) 	<ul style="list-style-type: none"> Work station Cycle Times. (T) Cycle time in fulfilling an order. (T) Degree of capacity utilisation. (O) Product development Cycle Time. (T) 	<ul style="list-style-type: none"> Adaptability of the supply chain to cope with an increase/decrease in market demand. (S) 	<ul style="list-style-type: none"> Rational use of available means to reach a predetermined objective. (T) 	<ul style="list-style-type: none"> Total transportation costs. (S/T) 	
Transport and distribution		<ul style="list-style-type: none"> Unloading time. (O) 		<ul style="list-style-type: none"> Percentage utilisation of float. (S/T) Customers' orders processed per person. (O) 		
Customer service	<ul style="list-style-type: none"> Percentage of errors in orders to supply. (O) Complete and on-time deliveries. (O) Level of Order Fulfilment. (S) 	<ul style="list-style-type: none"> Quality of delivery. (T) Mean Customer wait time. (S) Delivery time. (S) 	<ul style="list-style-type: none"> Time for processing orders to supply. (O) Flexibility to cover Customers' needs. (S) 			
Reverse logistics / return			<ul style="list-style-type: none"> Percentage of packages recycled. (T) 		<ul style="list-style-type: none"> Percentage of non-reusable products returned. (O) Percentage of packages collected. (T) Cost of reverse logistics. (S) 	

Note: S, Strategic; T, Tactical and O, Operation.

has not been proved in other sectors. Furthermore, the benefits to be gained by the enterprises from applying the methodology have not been measured objectively but are instead goals perceived by the managers. Although their experience leads us to suppose that they have been obtained, the method is not as exact as a quantitative analysis.

On the other hand, with regard to future prospects of the research, this study can be considered the starting point for future work that will complement the theoretical methodological approaches proposed in this article by refining some of the phases that have been outlined and by detecting SCI facilitators or new obstacles which will place new requirements on the methodology.

Hence, the methodology could be enriched by focusing on how to overcome the obstacles that have received the least attention, such as those related with the difficulties SMEs often have to gain access to ICTs, due to their high price and complexity, and especially the new Internet-based solutions, e-SCM. Likewise, it could also benefit from finding solutions to problems due to the (generally) insufficient investment in R&D, which limits the introduction of continuous improvement processes in the supply chain.

Other future work should check the validity of the proposed methodology by applying it to other type of industrial SMEs like the chemical or machine tools industries and to other activity sectors. Perform statistical analyses to determine the difference between the benefits obtained in each sector could then be done.

Finally, future study that is proposed is to adapt the methodology to the necessities of virtual SCI, and to extend the methodology to allow the integration of all the supply chain, not only the integration of the SME with the enterprises directly but also involved in the upstream and downstream SME flows.

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