



Industrial Performance Center

Massachusetts Institute of Technology

IPC Working Paper Series

CUSTOMER-SUPPLIER INTEGRATION IN THE ITALIAN HIGH PRECISION AIR CONDITIONING INDUSTRY

ARNALDO CAMUFFO, ANDREA FURLAN, AND PIETRO ROMANO

MIT-IPC-05-001

FEBRUARY 2005



292 Main Street, E38-104
Cambridge, MA 02139-4307
P 617-253-7522
web.mit.edu/ipc/www



The views expressed herein are the author's responsibility and do not necessarily reflect those of the MIT Industrial Performance Center or the Massachusetts Institute of Technology.

Customer-Supplier Integration in the Italian High Precision Air Conditioning Industry*

Arnaldo Camuffo
Department of Economics
University of Padova
Via del Santo 33
35123 Padova, Italy
Tel +39 049 8274232 – Fax +39 049 8274211
e-mail: arnaldo.camuffo@unipd.it

currently at:

Industrial Performance Center - Massachusetts Institute of Technology
292 Main Street - E38 - Cambridge, MA, 02139-4307, USA
telephone: (617)-253-0142
facsimile: (617)-253-7570
e-mail: acamuffo@mit.edu

Andrea Furlan
Department of Economics
University of Padova
Via del Santo 33
35123 Padova, Italy
Tel + 39 0498274235 – Fax +39 049 8274211
e-mail: andrea.furlan@unipd.it

Pietro Romano
Department of Electrical, Managerial and Mechanical Engineering
University of Udine,
Via Delle Scienze, 208
33100 Udine, Italy.
Tel +39 0432 558246 – Fax +39 0432 558298
E-mail: pietro.romano@uniud.it

February 2005

* We wish to thank Suzanne Berger, Charles Fine, Robert Gibbons, Richard Lester, Richard Locke, Carlos Martinez-Vela and Manus Rungtusanatham for suggestions and comments on earlier versions. Research funded by MIUR.

Customer-Supplier Integration in the Italian High Precision Air Conditioning Industry

ABSTRACT

Integration between customer and supplier is one of the important concepts in supply chain management. Both in theoretical and empirical contributions, it is shown that integrative practices improve supplier relations performance. By analyzing 9 case studies of customer-supplier relationships in the Italian high precision air conditioning industry, this paper investigates what suppliers and customers do in order to integrate their operations across the supply chain. It articulates customer-supplier integration (CSI) practices into four areas: three specific business processes – new product development, logistics, and pricing – and the more general customer-supplier knowledge transfer. This paper proposes a framework and develops propositions regarding the influence of the value impact of goods purchased from each supplier and of the degree of purchasing goods customization on the characteristics of customer-supplier integration.

Keywords: customer-supplier integration, supply chain management, supplier relations, business processes, multiple case study

INTRODUCTION AND THEORETICAL BACKGROUND

Several authors recognized that integration is a fundamental principle of SCM (Hewitt, 1992; Bechtel and Jayaram, 1997; Cooper *et al.*, 1997; Gould, 1998; Mabert and Venkatraman, 1998; Tan *et al.*, 1998). Customer-supplier integration (CSI) policies and practices aim to develop and sustain processes to strengthen and streamline inter-organisational relationships so that they can result in mutual gains for both parties (Cooper *et al.*, 1997; Barratt, 2004). CSI practices include the development of collaborative/long-term buyer–supplier relationships (e.g. trust based annual negotiations to price key-inputs, joint planning, risk sharing mechanisms, joint ventures, partnerships), the regular visiting of supplier facilities, the continuous monitoring of supplier base performance, and the involvement of suppliers in process/product innovations/improvements and in quality management.

The concept of CSI as a set of practices to support business processes across supply networks is closely related with the effort to overcome intra- and inter-organisational distrust and blur the corresponding boundaries. Thus, the very different perspectives authors adopt to deal with integration (i.e. functional, business process, information/materials flows, and information and communication integration) share the common aim to shift from local optimisation to system optimisation.

Though this wide acceptance, many problems remain about how best to characterize the business integration strategies (Bensaou and Anderson, 1999; Frohlich, Westbrook, 2001; Van der Vaart and van Donk 2001). Two of these problems are of particular interest here.

Firstly, even if one of the key aspect of the supplier network management is to determine what type of involvement/integration a manufacturer should develop with the various suppliers (Petroni and Panciroli, 2002), only few studies have taken into account the differences in the task of managing supplier networks in different industrial and competitive contexts (Lamming *et al.*, 2000). In fact, as emphasised by the literature on supplier relations portfolio models (Kraljic, 1987; Turnbull, 1990;

Olsen and Ellram, 1997; Benseau, 1999), CSI practices might differ across different industries, and diverse *driving aspects* of integration (e.g. customer-supplier dependence, sourcing strategies, legal ties, exchanged product characteristics) may be important under different circumstances (Scott and Westbrook, 1991). As argued by Mouritsen *et al.* (2002), more needs to be known about under which circumstances different supply chains and integration of activities and processes within the supply chain are beneficial for the participants.

Secondly, few studies take into account the multidimensional nature of CSI. Indeed, literature on CSI either tends to concentrate on individual aspects of customer-supplier relations - i.e. logistics (Hewitt, 1997; Sahin and Robinson, 2001), contracting and negotiation (Cachon and Lariviere, 2002; Ellram, 2002), new product development (Clark, 1989), quality management (Romano and Vinelli, 2001), knowledge management (Kotabe *et al.*, 2003) - or adopts a very general and all-encompassing approach to interfirm collaboration (Dyer and Ouchi, 1993; Helper and Sako, 1995; Cousineau *et al.*, 2004).

We maintain that, although research has made clear the goals of CSI, there has been little investigation – especially empirically based - about effective CSI practices simultaneously supporting several business processes as well as the characteristics of the context where the customer-supplier relationships take place. It is also because of this lack that CSI literature, to date, has not succeeded in providing managers with effective and practical criteria to select appropriate sets of initiatives to realize integration (Cooper *et al.*, 1997).

The aim of this paper is to empirically:

- a) explore what suppliers and customers do in order to integrate their operations across the supply chain;

- b) investigate the relations between these CSI practices and a set of business processes involved in customer-supplier relationships;
- c) identify on what driving factors these specific integration practices are contingent.

To address these research objectives, we studied 9 supplier relations in the Italian high precision air conditioning (AC) industry.

First, we analyzed CSI focusing on three business processes usually considered fundamental in customer-supplier relationship management, especially by the mainstream literature on “lean supplier practices” (Helper, 1991; Dyer and Ouchi, 1993; Helper and Sako, 1995; Mac Duffie and Helper, 1997): new product development, logistics and pricing. Moreover, following Sabel (1995) and Kotabe *et al.* (2003), we considered that CSI also encompasses a more general process knowledge transfer between customers and suppliers.

Second, we studied several driving factors identified by literature as the most relevant to be considered in the management of supplier relationship portfolios.

Third, we searched for relationships between the driving factors and the employed CSI practices.

Finally, we developed a framework and a set of research propositions regarding the influence of the driving factors on the management of different forms of CSI.

The paper is organized as follow. Section two explains the research constructs and their operationalization. It also gives information about the industry setting of the study, the sample and the research methodology. Section three contains the within case analysis of the 9 supplier relations while section four interprets the results of the cross-case analysis. Section five concludes the paper.

RESEARCH DESIGN

Research constructs

This study aims to contribute to CSI theory building, by developing testable propositions that could be generalized in diverse industry settings and business environments. In order to do so, following Eisenhardt (1989), Handfield and Melnyk (1998) and Meredith (1998), we chose multiple case study as research methodology, being this the particularly appropriate to describe and explore new phenomena or to build new operations management theories. As suggested by Yin (1994), we firstly conducted a review of relevant literature to identify the research constructs to be used to frame further investigation and formulate research hypothesis. These research constructs are divided into two categories: one the one hand those related to the content of CSI, on the other those concerning the driving aspects of CSI. As for the content of CSI, following literature on supply chain integration (Hewitt, 1997; Cooper *et al.*, 1997; Gould, 1998; Mabert and Venkatraman, 1998; Tan *et al.*, 1998; Frolich and Westbrook 2001; Romano, 2003), we defined CSI as the effort to overcome intra- and inter-organizational boundaries (e.g. information exchange, residential engineers, inter-organizational NPD teams) to support business process across a supplier relation. Moreover, we declined the content of CSI in the key business processes that compose any supplier relation. Lamming (1993) identifies nine factors that need to be considered in the analysis of the relationship between an assembler and a component supplier. These factors can be reorganized in four processes that characterize a supplier relation and that link the buyer's activities with those of the supplier: new product development, logistics, pricing and knowledge transfer. Based on an extensive review of the empirical literature on vertical relations (Clark, 1989; Sahin and Robinson, 2001; Takeishi, 2001; Ellram, 2002; Kotabe *et al.*, 2003), we provide definitions and measures of CSI for each of the four analyzed processes (Table I). Each

measure (or item) tries to capture the extent to which both the supplier and the customer overcome reciprocal organizational boundaries in managing each of the four business processes.

As for the driving aspects of CSI, literature on portfolio models of supplier relations (Kraljic, 1987; Turnbull, 1990; Scott and Westbrook, 1991; Olsen and Ellram, 1997; Benseau, 1999) identifies several drivers affecting the choice of CSI practices and explaining why companies tend to adopt certain forms of integration. For example, Olsen and Ellram (1997) propose several kind of driving factors: some influencing the strategic importance of the purchase (i.e. value of the purchase), some describing the difficulty of managing the purchase situation (i.e. the complexity of the purchased products), some influencing the relative supplier attractiveness (i.e. supplier's scale and experience) and some describing the strength of the relationship (i.e. importance of the buyer to the supplier).

Based on this stream of literature, we identified the following driving factors as some of the most important potential drivers that may have an impact on the management of CSI: supplier's scale, distance from the OEMs plants, value impact of the purchased good, supplier business concentration, purchased goods customization, longevity of the relation, buyer's sourcing strategy, and presence of legal ties. Table I gives definitions and measures used for each of these drivers.

Table I about here

Industry overview, sample and research methodology

To pursue the research goal, we studied 9 supplier relations of two Italian AC (Air conditioning) OEMs.

Obviously, the choice of industry setting is a crucial concern for a qualitative study on the nature of supplier relations. Why did we choose the Italian AC Industry?

First of all, for its primary role in the Italian economy. The world-wide AC market is about € 35 billion and the European market about € 10 billion. Italy is the main European market with a market share of about 29% and an annual growth rate greater than 5%. Italy also represents the major European producer, covering about 70% of total European production and leading several segments such as those of chillers and high-precision air conditioners.

Even more important than the first point, the Italian AC industry presents several characteristics that make it an ideal empirical setting for a study on the nature of supplier relations.

Firstly, particularly in some segments such as high precision conditioners and chillers, final products are highly complex (Clark and Fujimoto, 1991). Indeed, they are composed of hundreds of components that are tightly interdependent. Any parts change (for example from a forward to a backward curved blade) must be further coordinated with the design of all the coupled parts (for example position and characteristics of condenser, shape of the shell, features of electronic devices). In such contexts, relation-specific assets and interorganizational knowledge-sharing routines are often necessary to coordinate firms that are reciprocally interdependent (Dyer, 2000). Therefore, vertical relationships have a crucial role in achieving the coordination of the whole value chain.

Secondly, AC OEMs outsource a great part of their value added, buying almost all the components from external suppliers. On average external components weigh more than 80% on the full manufacturing costs of two analyzed OEMs. Therefore, supply management becomes crucial to achieve and sustain competitive advantage.

Thirdly, AC supplier's contributions to the innovation process are remarkable. Co-development and black-box practices of the two analyzed OEMs account for 42% of the final manufacturing cost while

the components that follow a traditional subcontracting system account for about 4%. This data highlights that the OEM relies heavily on the knowledge base of its suppliers in the sense that “rapid and reliable product innovation depends on the reliance on outside partners” (Lorenzoni *et al.*, 2002, p.13).

In order to make the results of our empirical study more reliable reducing the disturbance of analysis, in choosing the two OEMs we employed a match-pair methodology. The two OEMs are high performing firms similar in size, products, and final markets. They operate the same business areas: high precision air conditioning units, chillers and modular floors. They both are important industry players: they account for more than 60% of domestic production of high precision conditioners and rank among the top 10 world producers.

2003 turnover of OEM1 was about 108 million € while 2003 turnover of OEM2 was about 70 million. Foreign sales cover more than 80% of the total sales of both the OEMs and their main foreign markets are French, Germany, United Kingdom, Benelux e Scandinavian Countries. They both have an average annual sale growth of 10%.

The two manufacturers are located in the same geographic area (North-east Italy) within an industrial cluster known as the *distretto del freddo* (“district of cold”) for the geographic concentration of firms active in the air conditioning and refrigeration industries.

We focussed our analysis on the two OEMs main product: high-precision air conditioners (or close control conditioners). This kind of air conditioners are used in technological rooms that requires the maintenance of a close control of the temperatures.

In a typical high-precision air conditioner about 90% of the components account for less that 1% of the full manufacturing cost of the final product (e.g. body panels, electric components). The few components that exceed this threshold have a weight that ranges from 5% to 20% of the full

manufacturing cost (e.g. compressors, heat exchangers). For this reason, one may take 1% as the threshold between low and high value component of a high precision conditioner.

The supplier networks of the two OEMs are composed by 245 and 179 suppliers. In 2002 purchasing volume totalled respectively € 50 million and € 30 million.

From the supplier networks of the two OEMs, we selected 9 component suppliers. Of these, 3 supply OEM1, 4 OEM2 and 2 supply both (see Table II).

As usually happens in case study research (Yin, 1984; Eisenhardt, 1989), the choice of the research sample was not random (random or statistical sampling) but theoretical (theoretical sampling). Firstly, we ensured the heterogeneity of the sample. We selected suppliers with different combination in terms of supplier technological evolution and characteristics of supplied products. Secondly, for reason of research relevance, the suppliers we chose have continuously supplied the OEMs at least for four years. As suggested by Ellram (1996) and Voss *et al.* (2002) to gather information a semi-structured interview guide has been developed upon a common case study protocol based on the review of literature, and discussions with several operations managers of firms involved in the study. Particularly, we conducted several semi-structured interviews based on the research protocol developed on the research constructs operationalized as reported in Table I - to the purchasing and R&D managers of the two OEMs. Furthermore, in order to avoid single-respondent bias, we also conducted semi-structured interviews to the sales and R&D managers of the nine suppliers. On the whole, 22 interviews were carried out and each one took 1-1.5 hours. The interviews were recorded and transcribed for the subsequent within and cross-case analysis.

As shown in Table I, information gathered from interviews regards both CSI practices and the potential drivers. We collected both qualitative information and quantitative information for each CSI item. Qualitative information describes the CSI practice employed by the firms for that particular item.

Quantitative information, based on managers' assessment, measures each CSI item on a five-point perceptual interval scale ranging from 1 (non – it means there is no customer-supplier integration) to 5 (extensive – it means there is an extensive customer-supplier integration). The items related to the same business process are then averaged to form the CSI index for that business process (see Table III).

Quantitative and qualitative information have been compared to control for their consistency. Thus, both qualitative and quantitative types of data were collected combined in the case study write-ups. All of them were used as important sources of evidence when developing an understanding of CSI in each case. As suggested by Hekkilä (2002), no single type of data was allowed to dominate. In fact, because of the research approach used and the relatively small sample sizes, this was considered an appropriate way to analyze the gathered data.

Finally, to ensure research reliability, we sought data triangulation by gathering information from other sources such as internal documents and direct observations.

CASE DESCRIPTION

Results of the within case analysis is summarized in Tables II and III. In particular, table II shows the data about the drivers of CSI, while Table III reports the CSI indexes (average of the quantitative information on the CSI items based on the managers' assessment on a 5 points Likert scale).

Table II and Table III about here

Now, we briefly describe qualitative information on CSI practices employed in each supplier relation. In this way we show the consistency between CSI practices (qualitative information) and CSI indexes (quantitative information).

New Product Development

From the analysis it emerges that both S1 (heat exchangers) and S2 (electronic devices) have valuable technological capabilities and carry out internally all the NPD phases (marketed goods). Consequentially, the level of information exchange between customer and supplier is low and there is a scarce integration between their R&D structures (CSI indexes: 1.6 and 2.3).

As opposed to S1 and S2, in the relations with S3 (heat exchangers) and S4 (evaporators) the OEMs achieve the highest level of integration in managing the development of the NPD process (CSI indexes: 4.3 and 4.7). Suppliers are early involved in the NPD (sometimes from the product concept) and an intense reciprocal interdependence relationship is established through the use of coordination mechanisms (Grandori and Soda, 1995) that realize a high integration between the companies' operations. Examples of these mechanisms are regular visits by the technicians and inter-organisational teams in charged of specific NPD projects.

As regards S5 (metal body panels), S6 (electric components) and S7 (electric components), a traditional subcontracting approach is employed. These suppliers do not yet have any project autonomy and OEMs provide them with detailed drawings and frequent information about new materials and their sources. Furthermore, OEMs require the suppliers to provide detailed information on the materials they actually used and on their 2nd-tier suppliers (CSI indexes: 3, 4 and 3.3). Information flow is mainly managed by the adoption of traditional coordination mechanisms (e.g. informal communication).

Finally, S8 and S9 (tubes and liquid receivers) supply simple and completely standardized products and no integration is achieved in the NPD process (CSI indexes: 1.3 and 1.3).

Logistics

In the relations with S1 and S2 the process that achieved the highest level of CSI is logistics (CSI indexes: 3,6 and 4). Given the high value of the supplied parts, this high integration is aimed at reducing inventory stock through synchronized replenishment policies. In both cases, production flows are pulled by the demand of the customer with weekly or daily deliveries. A high information sharing on production schedules of the suppliers supports the coordination of logistics. Furthermore, it has been planned the adoption of on-line systems (i.e. on-line scheduling systems) to facilitate information exchanges.

In the relations with S3 and S4, firms achieve a high (although not the highest) CSI level (CSI indexes: 4 and 3). Even in these cases production flow is pulled by OEMs' needs and it leads to frequent deliveries. Finally, even if coordination mechanisms are still traditional (e.g. traditional order launching), a great amount of information about logistic process is exchanged (e.g. production schedules, OEMs' yearly forecasts).

Also in the relationships with S5, S6 and S7 logistics achieves a good level of CSI (CSI indexes: 4, 3 and 4). However, in S6 and S7 logistics shows the lowest level of CSI if compared with the other processes. In these cases, the realization of highly integrated logistics is limited by a scarce internal integration within the suppliers' organisational structures. Technological and managerial evolution of these suppliers is therefore a necessary condition for the implementation of integrated logistic systems.

Finally, with regard to S8 and S9 scarce integration is achieved in logistics (CSI indexes: 1 and 1.5).

Pricing

S1 and S2 provide little information concerning the cost structure and breakdown process and the employed coordination mechanisms are based exclusively on the informal negotiation between the respective interface functions (CSI indexes: 1 and 1.3). The scarce integration between customer and supplier mirrors the fact that the OEM does not have the competence, the contractual strength, nor the interest to intervene in the suppliers' manufacturing processes in order to increase their efficiency and innovativeness.

The greater CSI level, compared to the previous cases, between S3 and S4 and the OEMs, reflects a greater integration in the management of the pricing process (CSI indexes: 3.3 and 3). The suppliers give customers access to information concerning the general structure of product costs, the organization of the manufacturing process, the raw materials and the supply sources. The OEMs also actively intervene in the pricing process, providing information regarding the performance of other suppliers and collaborating with the supplier to identify possible areas of improvement. This greater interdependence is governed both by the usual communication and negotiation mechanisms as well as the creation of inter-organizational interface and integration units.

In the relationship with S5, S6 and S7 the pricing process achieves a very high level of CSI (CSI indexes: 4, 4.7 and 4.7). Such a process, in fact, does not only have as an output the price determination of the component to be purchased but it is a fundamental tool that carries the OEM's interventions in the suppliers' development and learning process. Suppliers provide the OEM with very detailed information regarding the breakdown process, the phase times and the cost structure. The detailed information exchanges serve to program OEMs' technical and managerial assistance that occurs systematically through 1) social coordination and control (e.g. residential engineers and regular visiting

of supplier facilities), and 2) integration and linking-pin roles (e.g. inter-firm project teams). In coordinating the pricing process, hierarchy and authority relations (Grandori and Soda, 1995) play an important role. This aspect is partially shown by the fact that the level of dependency of these suppliers (13%, 68% and 22% respectively) is significantly higher than the level of dependency of the other suppliers.

Finally, with regard to S8 and S9 no integration is achieved in the pricing process (CSI indexes: 1 and 1).

Knowledge Transfer

In the cases of S1 and S2 a low CSI is achieved in managing knowledge transfer (CSI indexes: 1.5 and 1.5). The party that benefits the most from the relation in terms of learning seems to be the OEM that feels these relationships as an opportunity for learning. Through these relationships, OEM can in fact access and eventually absorb several technical aspects of the core cooling technology. The level of integration to support these exchanges is realized mainly through supplier's personnel visits.

With S3 and S4, parties achieve a greater technical exchange reciprocity compared with the previous cases (CSI indexes: 3 and 2.5). In other terms, both the supplier and the customer learn from the relation through the knowledge of the other partner. However, knowledge transfer is limited to technical and codified exchanges not involving complex and tacit body of technological and managerial knowledge. Regular meetings and long-term personnel visits are the coordination mechanisms that are most used to govern interdependencies between the partners.

In the relationships with S5, S6 and S7, the integration achieved in managing knowledge transfer is fundamental in supporting suppliers' development (CSI indexes: 5, 4 and 4). According to Kotabe *et al.* (2003), the three cases show that the transfer of complex and partially tacit knowledge requires the use

of a variety of coordination mechanisms: informal daily contacts and technicians visits to the supplier's factories, residential OEM's engineers, training courses organized by the OEMs, inter-firm project teams, evaluation and monitoring systems and so forth. Furthermore, from the analysis it emerges that sharing the partnership's gains (e.g. price bonus paid by the OEM) is an essential incentive for the process to be successful.

Finally, with regard to S8 and S9 low integration is achieved in knowledge transfer (CSI indexes: 1.5 and 1).

CROSS-CASE ANALYSIS AND INTERPRETATION OF RESULTS

Table IV provides correlations between CSI indexes and the analyzed drivers.

Table IV about here

Customization of the purchased goods shows a high positive correlation with both the average value of CSI for each process and the global average CSI (0.96). Suppliers providing highly customized goods (S3, S4, S5, S6, S7) are characterised by high CSI indexes. Suppliers providing standardized or commodity-like goods (S1, S2, S8 and S9) show low CSI indexes. The degree of customization of components seems to increase the importance of the CSI in that it allows the achievement of the final product differentiation. This first result is coherent with Dyer *et al.* (1998)'s research on supplier segmentation. The authors argue that to optimize purchasing effectiveness supply management practices should be differentiated between suppliers providing customized parts and suppliers providing more standardized or commodity-like parts. Since resources are scarce, they should be allocated to the relationships with those high customized suppliers who fall in the first category.

Also value impact seems to exert some influence on CSI practices (correlation with global average CSI is 0.43). Several studies confirm that that management of the business processes typically varies with the value and the complexity of the products being supplied (Dyer *et al.*, 1998; Monczka *et al.*, 2002; van Weele, 2002). These studies suggest that a distinction between low-value impact and high-value impact suppliers has to be made. Moreover, this seems coherent with literature on supplier relations/supply chains portfolios that introduces the distinction among important *vs* non important items (Kraljic, 1983) or simple *vs* complex products (Lamming *et al.*, 2000). Our interviews suggest that, even if the value is not necessary associated with the strategic importance of the suppliers, management of high value suppliers should be differentiated from the management of low value suppliers. For example compressors are high-value components in high precision conditioners (about 20% on the full manufacturing cost) but in many cases they are a commodity-like part without any adaptations to the customer's needs. However, given the high value of these components, some business processes (e.g. logistics) have to be differentially managed from the same business processes of the relations with low-value suppliers.

Supplier's business concentration shows a high correlation with the global CSI (0.62). However, according to Okamuro (1997), business concentration is itself a measure of CSI (the more the supplier's business is concentrated to a specific customer the more the firms' operations are integrated) rather than a driver. Confirming this line of reasoning, Dyer *et al.* (1998) find that a characteristic of strategic partnerships is a higher business concentration rate than arm's length relationships (e.g. 60% *vs* 18.9% in the Japanese sample). Thus, in accordance with the cited studies, we consider supplier's business concentration as a characteristic and not as a contextual factor (driver) of CSI.

Supplier's distance have a high negative correlation with global CSI (-0.61) and with each of the CSI index. This result is coherent with other studies (e.g. Dyer 1996; 1997) that indicate geographical

proximity as on the major factor supporting collaboration between buyers and suppliers. For example Dyer (1996) show that suppliers and manufacturers that locate their plants close to each other tend to have lower buffer stocks and lower inventory costs than those that do not. Again, as done for supplier's business concentration and in accordance with Dyer *et al.* (1998) and Benseau (1999), we consider geographical proximity as a characteristic of the supplier relation that can support interfirm collaboration rather than a contextual factor.

Finally, the other drivers (i.e. supplier's scale, longevity of relations, sourcing strategy and legal ties) show low correlation with the global average CSI (ranging from -0.26 to 0.02).

Based on the above considerations, we propose product customization and product value impact as the two most relevant drivers for CSI among those we have studied. We therefore, classify the supplier relations in four groups on the base of the value of product customization (low, high) and product value impact (low, high). For each of the four group we synthesize the CSI practices employed by the firms in managing each of the four analyzed business process (Figure I).

Figure I about here

We now derive some empirical generalisations that we frame in the form of theoretical propositions to be tested by future research. In formulating these propositions, we assume that the supply management practices employed by the two OEMs of our sample are best practices given the high performance rate of both the buying firms and their leading position in the world-wide AC high precision industry.

1st Quadrant: low product customization and low product value impact (S8, S9)

S8 and S9 supply non-strategic goods. These items are low value impact and commodity-like components (i.e. tubes and liquid receivers) that are not customized to a particular customer's model (marketed goods). As a consequence, it is not important for the suppliers and the OEM to coordinate closely in design, development, manufacturing activities and logistic (Dyer and Ouchi, 1993). Information exchanges are limited to the materials used in the production process and thus there is the absence of any assistance and knowledge transfer between buyer and supplier. Also in pricing the level of integration is low. Finally, in both cases, the business concentration is low and the distance seems to have non influence (10-100km in the first case and 100-1000km in the second case).

In sum, relationships with S8 and S9 have three main characteristics. Firstly, given the low product complexity and the mature technologies, supply markets are fragmented and the price paid by the buyer is regulated by market competition. Secondly, the components have a low ability to influence the cost/value of the final product given their low value added. Thirdly, there is no need for relation-specific assets and coordination mechanisms given the low degree of buyer-supplier interdependence.

Interestingly enough, relationships are long (more than 10 years in both cases) and the buyer's sourcing strategy involves a low number of competing suppliers (3 for S8 and 1 for S9). Hence, the approach employed by the OEMs in managing these suppliers is coherent to what Dyer *et al.* (1998) name durable arm's length relationships. Keeping the number of supplier low and enhancing competition between two or three suppliers, buying firms can minimize transaction and procurement costs, allow suppliers to maximize economies of scale (which is critical in standardized, commodity-like products) and maintain vigorous competition (McMillan, 1990; Dyer and Ouchi, 1993; Dyer *et al.* 1998).

Thus, our first proposition is the following:

Proposition 1: when customer requires low product customization from suppliers and supplied parts have low value impact on the customer final product, CSI tends to be low for all the 4 analysed processes. This form of CSI configures a durable arm's length relationship.

2nd Quadrant: high product customization and low product value impact (S5, S6 and S7)

S5, S6 and S7 provide goods customized on the customer's needs. Even if these components have a low product value impact (less or equal to 1% on the full manufacturing cost), they allow OEMs to differentiate their final products.

An example are the body panels (S5) that composed the metal structural frame of an high precision conditioner. Outside metal panels are made with particular materials (e.g. cold-dip zinc-plated sheet steel) and have important functionalities perceived by the final customer (e.g. they insulate heat and sound according to legislation in force).

These components requires a high degree of coordination between supplier and customer on a multiple function-to-function interfaces. Buyer has to share technical and commercial information on product development and manufacturing to ensure that suppliers clearly understand the role of their component for the final customers and that the product can be easily assembled at the buyer's plant. To coordinate effectively the product development and the logistics, relation-specific investments (e.g. dedicated plant and equipment, dedicated personnel) are made both by the buyer and by the supplier (Dyer, 1996; Dyer, 1997).

An important aspect of the CSI for these components is the assistance provided by the OEMs to protect these suppliers and fostering their technological capabilities. The importance of the OEM's assistance to these suppliers is reinforced by the fact that the suppliers in our sample are medium-to-small firms with a low level of technological and design capabilities (i.e. in all the cases the detailed drawings of

the component are entirely provided by the OEMs). Such buyer's assistance is carried out both thorough knowledge transfer and pricing process. As stated by the purchasing manager of OEM1:

...we are training this supplier [S5]. This is very important because it is the only way to be always a step further than our competitors. If they don't know the technologies of, say, a metallic part, we can transfer important notions; why? because we have decided that it will be our supplier for that part and we want only capable suppliers.

Relationships between OEM2 and S6 provides another good example. The initial price for new components is determined using target costing. As the purchasing manager of OEM2 in charge of the relation states:

...we start from the target cost of the machine, then we section by component on a family basis and in the case of the electrical panel [S6], we determine how much the panel should cost; then the technicians make a more detailed analysis and determine the target cost; subsequently we obtain three or four offers from the market. If there are macroscopic differences, we discuss them with S6.

In carrying out this process S6 provides very detailed information regarding its costs structure and the breakdown process such as bills of materials and the time/cost of each production phase (wiring, assembly, etc). Further, OEM2 often intervenes to support S6 in improving its manufacturing processes. According to a OEM2's R&D manager:

S6's costs have diminished because, thanks to us, it has optimized its manufacturing process; it should thank us because we have given it the opportunity to improve its processes which has allowed it to maintain the margins and increase business

OEM2 and S6 use several coordination mechanisms in the pricing and knowledge transfer process. Daily telephone calls and weekly meetings are the more traditional ones. Further, OEM2 has recently sent six residential engineers to the supplier's plant in order to transfer know-how concerning the assembly of the panels and to provide assistance. Lastly, the transfers of complex and tacit bodies of

knowledge are also supported by relations consolidated over a long period that encourage the development of relation-specific assets (Asanuma, 1989; Levinthal and Fichman, 1991; Dyer and Singh, 1998).

One can argue that the emphasis given to the pricing process is not coherent with a contextual profile characterized by a low value of the purchased part. However, in these relationships pricing is not interpreted as a cost saving practice, rather as an opportunity to exert the *voice* option in developing the supplier (Hirshman, 1970). Moreover, though the parts have a low value, S5, S6 and S7 are class A suppliers because of the high volume purchased by the OEMs (from 2 to 6% of the purchasing budgets).

In sum, S5, S6 and S7 are small Italian subcontractors located near the main customers (S6 and S7 are few meters far from the OEMs while S5 is few kilometres far from OEM1) that provide low value products with a high degree of customization. In spite of the low value of the products they provide, these suppliers play an important role in differentiating the buyer's final product but they need a strong assistance by the buyer to evolve and enhance their design, technological and managerial knowledge (Grandinetti, 2003). The buyer has strong incentives to develop the supplier for two reasons. Firstly, given the importance of the purchased parts, the buyer wants a trustworthy partner more and more capable to develop autonomously good products. Secondly, each party makes co-specialized investment that are of little value outside the relationship, creating a situation of co-specialized investments that serve as a self-enforcing safeguard of the relationship (Williamson, 1985).

The management of these relationships involves a high interaction between the buyer and the supplier, especially in knowledge transfer and pricing that are the business processes through which the buyer provides assistance to the supplier. As an effect of this high buyer-supplier interaction, organizational boundaries between the buyer and the supplier begin to blur.

In spite of the high integration, these forms of CSI do not configure what the literature indicates as strategic partnerships (Dyer *et al.* 1998; Bensaou, 1999). Indeed, there is a strong asymmetry between the parties. First of all, the supplier has scarce design capabilities and does not have any project autonomy. Moreover, the buyer is significantly greater than the supplier and the supplier's business is highly dependent on the buyer (e.g. S6 has 68% of business concentration on OEM1). However, in these relationships, the OEM exploits its high power not only to keep the supplier under competitive pressure but also to develop its technological capabilities.

The second proposition follows:

Proposition 2: when customer requires high product customization from suppliers and supplied parts have low value impact on the customer final product, interacting companies seek to achieve a medium-to-high level of CSI in logistics and NPD and a high level of CSI in pricing and knowledge transfer in order to support the development of the supplier. This form of CSI configures an asymmetric partnership relationship in which customer is dominant.

3rd Quadrant: low product customization and high product value impact (S1 and S2)

S1 and S2 are medium firms specialized in the production of high value and complex components. For example, S2 is a world-leading company in electronic systems for AC temperature control with a share of the non captive European market of 70%. World-wide S2 has thousands of customers of which 2/3 OEMs (above all in the AC industry, OEM1 is its main customer) and 1/3 installers and commercial companies (above all in the refrigeration industry). S1 and S2 develop in-house their products and sell them to a variety of customers with marginal adaptations.

Given their high value added and their importance for the basic product functionalities, these components play an important role for the success of the final product. However, they are typically

subjected to industry standards and are scarcely differentiated among the competitors. These components are developed only by the supplier (marketed goods) that owns the technological skills, knowledge and resources to carry out in-house R&D. Moreover, many of these complex components have a modular architecture that minimizes the interactions with other components of the air conditioners (Baldwin and Clark, 1997).

On the whole, given the low buyer-supplier interdependence and the high level of supplier's autonomy, there is scarce CSI on NPD. Also in pricing a scarce CSI is realized. Indeed, the OEM does not have the competence nor the power to intervene in supplier's internal operations.

Logistics becomes the central process for the OEMs that seek to achieve potentially traded-off goals: minimize inventory and avoid risks of stock-out. S2 and OEM1 are implementing a kanban system that is expected to minimize inventory stocks and replenishment lead times. In this case, synchronization of logistics is however facilitated by the closeness of the buyer-supplier's facilities that allows S2 to frequently deliver products thereby minimizing the inventory stock. Also in the relationship involving S1, the intensity of information exchanges regarding planning systems, production plants and inventory confirms the importance of the CSI in managing logistics processes.

In the learning process the party that benefits the most seems to be the OEM. By interacting with these suppliers, the OEM has the possibilities to learn important technical aspects and marketing trends of some core technologies (e.g. compressors, electronic controls). Informal communication and visits of supplier's technicians are the coordination mechanisms used by the OEM to learn from the suppliers.

As happens in the 2nd quadrant, again this CSI form is not coherent with a strategic partnership approach (Lamming 1993; Dyer *et al.* 1998; Kotabe *et al.* 2003), because it is characterized by an exchange of high value and standardized product, a low buyer-supplier interdependence, and an asymmetric balance of power between the parties. The supplier has a high market power and owns

important core technologies that are sold to a large base domestic and international customers. From a transaction costs economics perspective, the supplier makes little relation-specific investments and thus has low costs of switching the customer (Williamson, 1985) even if we can imagine that others self-enforcing mechanisms (e.g. the reputation effect) may take place within the relationship (Benseau and Andersen, 1999).

However, this CSI form does not configure a situation of durable arm's length relationship given the facts that a good logistics integration is realized by the parties and that a low unidirectional flow of knowledge transfer (from supplier to OEM) occurs. Thus, the parties develop a form of relationship that lies between durable arm's length relationships and an asymmetric partnership where supplier is dominant:

Proposition 3: when customer requires low product customization from suppliers and supplied parts have high value impact on the customer final product, interacting companies seek to achieve a low level of CSI in pricing, NPD and knowledge transfer and a high level of CSI in logistics. This form of CSI configures a relationship that lies between a durable arm's length relationship and an asymmetric partnership relationship in which supplier is dominant.

4th Quadrant: high-product customization and high product value impact

S3 and S4 supply high value components that tend to be highly customized to the OEM's particular needs, thus playing an important role in differentiating OEM's final product.

For example, S3 is a medium producer of condensers for the AC and refrigeration sectors. It offers a wide range of off-the-shelf products that, for the most important customers, are subjected to significant adjustments and customization. Condenser is a high value component that represent one of the key parts of the a cooling system. The condenser has to be adapted both to technology and to the product

architecture employed by the OEM (e.g. internal or external condenser, water or air cooled condenser). Furthermore, it has high level of functional interdependence with other parts of the air conditioner (e.g. blades, metal frame, electronic control system).

Given the characteristics of the provided components, S3 and S4 are early involved in OEM's NPD process and for each NPD project, inter-organisational teams made up of technicians of the two partners are set up in order to coordinate the innovation process. Technical information exchanges supporting NPD process are frequent and facilitated by frequent meetings between personnel of the two firms as well as by the use of dedicated organizational units.

Also in logistics, parties achieve a good level of integration with the aim to streamline the production flow. For both these processes (NPD and logistics), geographical proximity facilitates information sharing and coordination (S3 is few meters far from the OEM1's plant while S4 is few kilometres far from OEM2's plant).

Both the relationships are associate with a high parties' commitment (Helper, 1991). The words of a S4's sales manager highlight this aspect:

...if a competitor of ours launches a product onto the market that crowds us out or makes a better offer, with OEM2 we can find a solution by talking about the product mix and we discuss about it; it has never happened that we have threatened to pull out of the relationship. Furthermore, OEM2 does not have any interest in whipping us on because we have shown ourselves trustworthy over time and able to follow his developments.

The commitment of the parties derive both from the fact that the success of the suppliers is closely tied to the success of the OEMs (Helper and Sako, 1995) and from the existence of co-specialized investments (e.g. dedicated equipment and plant, tailored manufacturing systems, dedicated personnel) by both the parties (Bensaou and Andersen, 1999).

Pricing and knowledge transfer process of both the suppliers is characterized by a medium level of CSI. S3 and S4 are medium firms that are specialized in specific segments of value chain and provide the OEM with strategic parts. These firms have good technical and managerial capabilities, they manage their own brands and they have a large base of domestic and international customers. Thus, knowledge transfer is not needed to enhance supplier's assets and capabilities but to jointly support the knowledge creation process and to help the parties to earn the common benefits (Khanna *et al.*, 1998) of the relationship.

We maintain that this is the only CSI form that configures a strategic partnership. Indeed, a high level of integration between parties is associated with a high level of reciprocal collaboration among parties that have posted highly idiosyncratic assets into the relationship (Bensaou, 1999).

The last proposition follows:

Proposition 4: when customer requires high product customization from suppliers and supplied parts have high value impact on the customer final product, interacting companies seek to achieve a medium-to-high level of CSI in logistics, pricing and knowledge transfer and a high level of CSI in NPD. This form of CSI configures a strategic partnership.

CONCLUSIONS

As can be concluded from the review of literature on supplier relations, most of studies either analyze one single aspect of customer-supplier relations or employ an all-encompassing approach to interfirm collaboration. Moreover, most of the empirical studies pay little attention to the context in which customer-supplier integration takes place as well as the processes it addresses (Dyer and Ouchi, 1993; Helper and Sako, 1995; Sahin, Robinson, 2001; Cachon and Lariviere, 2002; Ellram, 2002; Kotabe *et al.*, 2003; Cousineau *et al.*, 2004).

This paper contributes to filling these gaps by investigating CSI forms involving four business processes usually considered fundamental in shaping OEM-supplier relationships: new product development, logistics, pricing and the more general knowledge transfer between customers and suppliers. Moreover, we strove to introduce the context dimension in our study by investigating how such processes contribute in shaping CSI forms in contexts characterized by different contingent factors.

By analyzing 9 customer-supplier relationships in the Italian high precision AC industry, we propose a framework that identifies four CSI forms contingent on the two contextual variables (value of purchased goods and degree of purchased good customization), and formulated four theoretical propositions explaining how each of the four forms of CSI is characterized by a different mix of integration practices in each of the four business processes.

This study presents both academic and managerial relevant implications that could offer clues for further research.

From an academic point of view, we contribute to the literature by proposing a framework that advance our understanding on the management of the supplier relations in two major ways.

First, our framework gets over the traditional dichotomy between arm's length relationships and strategic partnerships (Dyer and Ouchi, 1993; Helper and Sako, 1995; Dyer *et al.* 1998) by identifying four forms of CSI. The first one configures a (durable) arm's length relationship and is adapted to contexts characterized by low value of purchased goods/low degree of purchased goods customization. The last one configures a strategic partnership and is adapted to contexts characterized by high value of purchased goods/high degree of purchased goods customization. The second and the third ones lie in between arm's length relationships and partnership with an asymmetric balance of power between customer and supplier. They are associated to contexts characterized by low value of purchased

goods/high degree of purchased goods customization, and high value of purchased goods/low degree of purchased goods customization, respectively.

Second, our framework characterizes each of the four CSI forms in terms of the practices employed by the buyer and the supplier to manage the four key business processes. Within the same CSI form, firms employ different mechanisms and achieve different level of CSI in managing the different business processes. This way, our framework advances the consolidated literature that either considers one single aspect of customer-supplier relations (i.e. pricing, logistics, or new product development) or interprets interfirm collaboration as a uni-dimensional phenomenon (Helper and Sako, 1995; Ellram, 2002; Kotabe *et al.*, 2003).

From a managerial point of view, following the recommendation of Van de Ven (1989), the theoretical results reported in the paper should provide guidance to managers facing the decision making process concerning the choice of the mix integrative practices to implement in the contexts highlighted in our framework. In particular, it is important that managers contemplating the implementation of CSI interventions (1) strive to highlight all the contextual drivers associated to the implementation of each intervention, and (2) choose the mix of interventions taking into account the business processes that best fit with the context. We think that this understanding should contribute to help managers direct CSI initiatives more consistently.

To conclude, three major limitations of the paper offer possibilities for future research. First, in this study, we have not directly investigated the relationship between integration and performance. However, we have assumed that supply management practices employed by the two OEMs are best practices given their high performance rates and their world-wide leaderships in AC high-precision industry. Another limitation of this study might be the restricted number of cases investigated: final

propositions could be tested in larger samples and in different industries. Third, further drivers can explain CSI and further business processes can be considered in the analysis.

REFERENCES

- Asanuma, B. (1989), "Manufacturer-supplier relationships in Japan and the concept of relation-specific skill", *Journal of the Japanese and International Economies*, Vol 3 No 1, pp. 1-30.
- Baldwin C., Clark K.B., 1997, "Managing in an age of modularity", in *Harvard Business Review*, Sep.-Oct., pp 84-93.
- Baratt, M. (2004), "Understanding the meaning of collaboration in the supply chain", *Supply Chain Management: An International Journal*, Vol 9 No 1, pp. 30-42.
- Bensaou, M. (1999), "Portfolios of buyer-supplier relationships", *Sloan Management Review*, Summer, pp. 35-44.
- Bensaou M., Anderson E. (1999), "Buyer-supplier relations in industrial markets: when do buyers risk making idiosyncratic investments?", *Organization Science*, Vol 10 No. 4, p. 460-481
- Bechtel, C., Jayaram, J. (1997), "Supply chain management: a strategic perspective", *The International Journal of Logistics Management*, Vol 8 No 1, pp. 15-34.
- Cachon G.P., Lariviere M.A. (2001), "Contracting to Assure Supply: How to Share Demand Forecasts in a Supply Chain", *Management Science*, 47 (5), May, pp. 629-646
- Clark, K.B. (1989), "Project scope and project performance: the effect of parts strategy on supplier involvement", *Management Science*, Vol 35 No 10, pp. 759-775.
- Clark K., Fujimoto T. (1991), *Product development Performance: Strategy, Organization and Management in the World Auto Industry*, Harvard Business School Press, Boston

- Cohen, W.M., Levinthal, D.A. (1990), "Absorptive Capacity. A new perspective on Learning and Innovation", *Administrative Science Quarterly*, Vol 35 No 1, pp. 128-52.
- Cooper, M.C., Lambert, D.M., Pagh, J.D. (1997), "Supply chain management: more than a new name for logistics", *The International Journal of Logistics Management*, Vol 8 No 1, pp. 1-13.
- Cousineau, M., Lauer, T.W., Peacock, E. (2004), "Supplier source integration in a large company", *Supply Chain Management: an International Journal*, Vol 9 No 1, pp. 110-17.
- Dyer, J.H. (1996), "Specialized supplier network as a source of competitive advantage: evidence from the auto industry", *Strategic Management Journal*, Vol. 17, p. 271-292.
- Dyer, J.H. (1997), "Effective Interfirm collaboration: How firms minimize transaction costs and maximize transaction value", *Strategic Management Journal*, Vol 18 No 7, pp. 535-556.
- Dyer, J.H., Ouchi, W.G. (1993), "Japanese-Style Partnership: Giving companies a competitive edge", *Sloan Management Review*, Fall, pp. 51-84.
- Dyer J.H., Cho D.S., Chu W. (1998), "Strategic Supplier Segmentation: the next "best practice" in supply chain management", *California Management Review*, vol. 40 no 2., p. 57-77
- Dyer, J.H., Singh, H. (1998), "The relational view: Cooperative Strategy and Sources of Interorganizational Competitive Advantage", *Academy of Management Review*, Vol 23 No 4, pp. 660-679.
- Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol.14 No.4, pp.532-550.
- Ellram, L.M. (1996), "The use of the case study method in logistics research", *Journal of Business Logistics* Vol. 17 no 2, p. 93-138.

- Ellram, M.L. (2002), "Supply management involvement in target costing process", *European Journal of Purchasing and Supply Chain Management*, Vol 8 No 4, pp. 235-244.
- Frohlich, M.T., Westbrook, R. (2001), "Arcs of Integration: an International Study of Supply Chain Strategies", *Journal of Operations Management*, Vol 19 No 2, pp. 185-200.
- Gould, L.S. (1998), "SCM: another acronym to help broaden enterprise management", *Automotive Manufacturing and Production*, Vol 110 No 3, pp. 64-70
- Grandinetti R. (2003), "The chair manufacturing district of Manzano: Evolutionary Process and the role of Institutions", in Belussi F., Gottardi G., Rullani E. (eds), *The Technological Evolution of Industrial Districts*, Kluwer, Boston
- Grandori, A., Soda, G. (1995), "Interfirm Networks: Toward a Theory of Interfirm Coordination Modes", *Organization Studies*, Vol 16 No 2, pp. 183-214.
- Handfield, R.B., Melnyk, S.A. (1998), "The scientific theory building process: a primer using the case of TQM", *Journal of Operations Management*, Vol 16 No 4, pp. 321-339.
- Hekkilä, J. (2002), "From supply to demand chain management: efficiency and customer satisfaction", *Journal of Operations Management*, Vol 20, pp. 747-767.
- Helper, S. (1991), "How much Has Really Changed between U.S. Automakers and their Suppliers?", *Sloan Management Review*, Summer, pp. 15-28.
- Helper, S., Sako, M. (1995), "Supplier Relations and Management: a Survey of Japanese, Japanese-Transplant, and US Auto Plants", *Sloan Management Review*, Spring, pp. 77-84.
- Hewitt, F. (1997), "Customer supply assurance management at Xerox", *Journal of the Canadian Association of Logistics Management*, Vol 3 No 2, pp. 10-12.

- Hirschman A.O., 1970, *Exit, Voice and Loyalty*, Cambridge, Harvard University Press.
- Khanna T., Gulati R., Nohria N., 1998, "The Dynamics of Learning Alliances: Competition, Cooperation, and Relative Scope", *Strategic Management Journal*, vol. 19, p. 193-210
- Kotabe, M., Martin, X., Domoto, H. (2003), "Gaining from vertical partnerships: knowledge transfer, relationship duration, and supplier performance improvement in the U.S. and Japanese Automotive Industries", *Strategic Management Journal*, Vol 24 No 4, pp. 293-316.
- Kraljic, P. (1983), "Purchasing must become supply management", *Harvard Business Review*, September/October, pp. 109-117.
- Lamming R. (1993), *Beyond Partnership*, Prentice Hall, London
- Lamming, R., Johnsen, T., Zhneg, J., Harland, C. (2000), "An initial classification of supply networks", *International Journal of Operations and Production Management*, Vol 20 No 6, pp. 675-691.
- Levinthal, D., Fichman, M. (1988), "Dynamics of inter-organizational attachments: auditor-client relationships", *Administrative Science Quarterly*, Vol 33 No 3, pp. 345-369.
- Lorenzoni, Lipparini, Zollo (2001), *Dual Network Strategies: Managing Knowledge-based and Efficiency-based Networks in the Italian Motorcycle Industry*, paper presented at the SMS 21st Annual International Conference, California, October 21-24
- Mabert, V.A., Venkataramanan, M.A. (1998), "Special research focus on supply chain linkages: challenges for design and management in the 21st century", *Decision Science*, Vol 29 No 3, pp. 537-552.
- MacDuffie, J.P., Helper, S. (1997), "Creating lean suppliers: diffusing lean production through the supply chain", *California Management Review*, Vol 39 No 4, pp. 118-151.

- McMillan J. (1990), *Managing Suppliers: Incentive Systems in the Japanese and US Industry*, California Management Review, Summer, pp. 38-55
- Meredith, J. (1998), "Building operations management theory through case and field research", *Journal of Operations Management*, Vol 16 No 4, pp. 441-454.
- Monczka, R., Trent, R., Handfield, R.B (2002), *Purchasing and Supply Chain Management* (second edition), Thomson Learning, London.
- Mouritsen, J., Skøtt-Larsen, T., Kotzab, H. (2002), "The Supply Chain Management Integration Assumption – its Dilemma, meaning and Validity", in Christiansen, J.K. and Boer, H. (Eds.), *Operations Management and the New Economy*, Proceedings of the 9th International Conference of the European Operations Management Association, Copenhagen, 2-4 June 2002, Volume II, pp. 1017-1026.
- Ollsen, R. F., Ellram L.M. (1997), "A Portfolio Approach to Supplier Relationships", *Industrial Marketing Management*, Vol. 26, pp. 101-113.
- Okamuro, H. (1997), "Risk sharing in the supplier Relationship: New evidence from the Japanese Automotive Industries", Discussion papers, Social Science Research Center, Berlin.
- Petroni, A., Panciroli, B. 2002, "Innovations as a determinant of suppliers roles and performance: an empirical study in the food machinery industry", *European Journal of Purchasing & Supply Management*, vol. 8, p. 135-149.
- Romano P. (2003), "Co-ordination and integration mechanisms to manage logistics process across supply networks", *Journal of Purchasing and Supply Management*, 9, p. 119-134

- Romano P., Vinelli A. (2001), "Quality Management in a supply chain perspective. Strategic and operative choices in a textile-apparel network", *International Journal of Operations & Production Management*, Vol. 21 no 4, p. 446-460
- Sabel, C.F. (1995), "Learning by Monitoring: The Institutions of Economic Development", in Smelser, N., Swedberg, R. (Eds.), *Handbook of Economic Sociology*, Princeton University Press, Princeton NJ.
- Sahin F., Robinson E.P. (2001), Economic Production Lot Sizing with Periodic Costs and Overtime, *Decision Sciences Journal*, Volume 32, Number 3, p. 423-452
- Scott, C., Westbrook, R. (1991), "New strategic tools for supply chain management", *International Journal of Physical Distribution and Logistics Management*, Vol 21 No 1, pp. 23-33.
- Takeishi A. (2001), "Bridging inter- and intra-firm boundaries: management of supplier involvement in automobile product development", *Strategic Management Journal*, Vol. 22 no 5, p. 403-433
- Turnbull P. (1990), "A Review of Portfolio Planning Models For Industrial Marketing and Purchasing Management", *European Journal of Marketing*, Vol. 24, No. 3, pp. 7-22.
- Van de Ven, A.H. (1989), "Nothing is quite so practical as a good theory", *Academy of Management Review*, Vol.14 No.4, pp.486-489.
- van Donk, D.P., van der Vaart, T. (2001), "Is integration (really) needed in supply chains?", in Blackmon K., Brown S. et al. (Eds.), *What Really Matters in Operations Management*, Proceedings of the European Operations Management Association, 8th International Annual Conference, Bath, 3-5 June, pp. 425-36.

van Weele, A.J. (2002), *Purchasing and Supply Chain Management: Analysis, Planning and Practice* (third edition), Thomson Learning, London.

Voss, C., Tsikriktsis, N., Frohlich, M. (2002), Case Research in Operations Management. *International Journal of Operations and Production Management* Vol. 22 no 2, 195-219.

Williamson, O. E. (1985), "The economic institutions of capitalism: firms, markets, relational contracting", Collier Macmillan, Free press, London, New York

Yin, R. (1994), *Case Study Research*, Sage Publications, Beverly Hills, CA.

Table I – Operationalization of the research constructs

CUSTOMER-SUPPLIER INTEGRATION (CSI)	
CSI for the new product development process	Definition: efforts to overcome interorganizational boundaries in managing negotiation process the new product development process. Measures: information exchange degree on materials/suppliers; interaction types in new product development (e.g. marketed goods, traditional subcontracting, black-box or co-development); use of interfirm teams for new product development; frequency of NPD interorganizational meetings (no regular visits, only when there is a problem, weekly, quarterly, annually, guests); usage of I&CT supporting information exchange on NPD process.
CSI for the logistics process	Definition: efforts to overcome interorganizational boundaries in managing the logistics process. Measures: visibility on supplier/customer inventory; common use of logistical equipment/containers; common use of third-party logistical services; usage of I&CT supporting logistics process; sharing production plans and access to planning systems; adoption of JIT or continuous replenishment.
CSI for the pricing process	Definition: efforts to overcome interorganizational boundaries in managing the pricing process. Measures: information exchange degree on (1) the supplier production process and system (production phases, planning system, sourcing policies, materials) and (2) the purchased goods cost structure; degree of cooperation in pricing (1 min: price is determined by the market/one party; 5 max: target costing).
CSI for knowledge transfer	Definition: efforts to overcome interorganizational boundaries in managing the process of technical and technological knowledge transfer. Measures: training at the supplier/customer plant organised by the customer/supplier; frequency of customer/supplier visits during last year (not once, once, 2 to 5 times, 6 to 10 times, adoption of residential engineers at the customer/supplier plants); degree of technical/managerial customer/supplier support.
POTENTIAL DRIVERS	
Supplier scale	Definition: supplier size. Measures: number of employees and sales volume
Distance from the OEM	Definition: Distance of the supplier's plant from the main plant of the OEM Measures: Distance range of the supplier's plant from the OEM's main plant to be served: 1) 10-10 km, 2) 10-100km, 3) 100-1000km
Value impact	Definition: value of goods purchased from a supplier as percentage of the full manufacturing cost of the customer's final product. Measures: weight of goods purchased from a supplier on the full manufacturing cost of the customer's final product.
Purchased goods customization	Definition: degree of purchasing goods customization Measures: degree of customization of purchasing goods to satisfy customer needs (1 – complete standardization, 2 – marginal adaptation, 3 – high adaptation, 4 – complete customization).
Supplier's business concentration	Definition: value of goods as percentage of the total turnover of the supplier. Measures: weight of goods sold to a customer on total turnover of the supplier.
Longevity of the relations	Definition: duration of customer-supplier relations. Measures: years since the first customer-supplier agreement.
Sourcing strategy	Definition: type of sourcing strategy (single sourcing, dual sourcing, etc.). Measures: Number of competing suppliers in the customer vendor lists for each purchased goods.
Legal ties	Definition: existence of contracts, shared patents, or other legally binding arrangement between customer and supplier. Measures: Number and type of legal arrangements between customers and suppliers.

e II – Drivers of CSI

	S1	S2	S3	S4	S5	S6	S7	S8	S9
Customer	OEM2	OEM1	OEM1	OEM2	OEM1	OEM2	OEM2	OEM1/OEM2	OEM1/OEM2
Products	Heat exchangers	Electronic devices	Condenser	Evaporators	Body panels	Electrical components	Electrical components	Liquid Receivers	Tubes
Sales	32 mil €	44 mil €	10 mil €	42 mil €	10 mil €	3 mil €	2 mil €	5 mil	26 mil €
Employees	330	440	70	294	100	25	30	48	90
Distance from the OEMs	10-100 km	0-10 km	0-10 km	10-100km	10-100 km	0-10km	0-10km	10-100km	100-1000km
Value impact (%)	10	3	8	11	1	<1	<1	<1	<1
Purchased goods customization	2	2	3	4	4	4	4	1	1
Supplier's business concentration (%)	3	5	7	8	13	68	22	<1	<1
Longevity of the relations (years)	4	>10	>10	5	5	>10	>10	>10	>10
Sourcing strategy	3	2	1	3	3	1	2	3	1
Legal ties	no	no	no	yes	no	Yes	no	no	yes

*Table III – CSI indexes**

	S1	S2	S3	S4	S5	S6	S7	S8	S9
<i>Average CSI for new product development</i>	1.6	2.3	4.3	4.7	3	4	3.3	1.3	1.3
<i>Average CSI for logistics</i>	3.6	4	4	3	4	3.6	3	1	1.5
<i>Average CSI for pricing</i>	1	1.3	3.3	3	4	4.7	4.7	1	1
<i>Average CSI for knowledge transfer</i>	1.5	1.5	3	2.5	5	4	4	1.5	1
<i>Global average CSI</i>	1.9	2.3	3.7	3.3	4	4.1	3.8	1.2	1.2

*Based on the information gathered by the empirical study (management assessment), CSI indexes have been derived from the average of the items related to each business process. It has been used a five-point scale ranging from 1(non CSI) to 5 (extensive CSI).

Table IV – Correlations between CSI indexes and drivers of CSI

	NPD CSI	Logistics CSI	Pricing CSI	KT CSI	Global CSI
Sales	0.00	0.27	-0.48	-0.49	-0.25
Employees	-0.12	0.35	-0.50	-0.47	-0.26
Distance from the OEM*	-0.54	-0.61	-0.55	-0.44	-0.61
Value Impact	0.41	0.26	0.46	0.32	0.43
Product Customization	0.85	0.62	0.92	0.87	0.96
Business concentration	0.47	0.29	0.71	0.58	0.62
Relational longevity	-0.08	-0.31	0.05	-0.13	-0.12
Sourcing strategy	-0.19	-0.07	-0.22	-0.02	-0.15
Legal ties**	0.27	-0.25	0.11	-0.09	0.02

* This variable scores 1 if supplier's distance falls within 0-10km range, 2 if supplier's distance falls within 10-100km range and 3 if supplier's distance falls in 100-1000km range

** This variable has been transformed in binary variable taking 1 if there are legal ties and 0 if there aren't.

Figure I – CSI forms

		Product Customization	
		Low	High
Product value impact	Low	<p>1st Quadrant (suppliers S8, S9)</p> <p>New Product Development (Average CSI: 1.3)</p> <ul style="list-style-type: none"> - Marketed goods <p>Pricing (Average CSI: 1)</p> <ul style="list-style-type: none"> - No target costing - Competitive bidding <p>Logistics (Average CSI: 1.25)</p> <ul style="list-style-type: none"> - Traditional system - Use of e-mail or fax for order communication <p>Knowledge Transfer (AverageCSI: 1.25)</p> <ul style="list-style-type: none"> - No knowledge transfer 	<p>2nd Quadrant (suppliers: S5, S6, S7)</p> <p>New Product Development (Average CSI; 3.4)</p> <ul style="list-style-type: none"> - Traditional sub-contracting - Detailed drawings provided by the OEM - OEM’s NPD teams for some components (e.g. electrical components) <p>Pricing (Average CSI: 4.5)</p> <ul style="list-style-type: none"> - Existence of formal contracts (3 years) - Target costing process - Detailed information exchange on production schedule, cost structure, materials, sourcing <p>Logistics (Average CSI: 3.5)</p> <ul style="list-style-type: none"> - Detailed information on production schedules - Use of e-mail or fax for order communication - Information sharing on OEM’s future plans <p>Knowledge Transfer (Average CSI: 4.3)</p> <ul style="list-style-type: none"> - Exchanges of technical and technological information - Informal communications - Visits of customer’s technicians/engineers - Customer’s residential engineers - (No formalized) incentive mechanisms in the form of gain sharing

<< Figure I – CSI forms(continued)

High	<p>3rd Quadrant (suppliers: S1, S2)</p> <p>New Product Development (Average CSI: 1.9)</p> <ul style="list-style-type: none"> - Marketed goods - Marginal exchanges of technical information - Scarce informal communication <p>Pricing (Average CSI: 1.1)</p> <ul style="list-style-type: none"> - Scarce information provided by the supplier - No target costing <p>Logistics (Average CSI: 3.8)</p> <ul style="list-style-type: none"> - Information sharing on OEM’s future plans - Use of e-mail or fax for order communication - Implementation of JIT and EDI systems <p>Knowledge Transfer (Average CSI: 1.5)</p> <ul style="list-style-type: none"> - Informal communications of technical and market trend information - Visits of supplier’s technicians at OEM’s plants 	<p>4th Quadrant (suppliers: S3, S4)</p> <p>New Product Development (Average CSI: 4.5)</p> <ul style="list-style-type: none"> - Black-box/co-developed goods - Information exchanges on supplier’s materials and sourcing information - Inter-firm NPD teams (integration units) <p>Pricing (Average CSI: 3.15)</p> <ul style="list-style-type: none"> - (Partial) use of formal negotiation mechanisms - Rigorous and formalized selection and evaluation systems - Information exchanges on breakdown of process steps and cost structure <p>Logistics (Average CSI: 3.5)</p> <ul style="list-style-type: none"> - Make to order - Information sharing on OEM’s future plans - Use of e-mail or fax for order communication - Information exchanges (access to) on production schedules <p>Knowledge Transfer (Average CSI: 2.75)</p> <ul style="list-style-type: none"> - Informal and formal communications - Visits of customer’s technicians - Exchanges of technical information - Inter-organizational team and integration units
-------------	---	--