The Role of SCM Capabilities to Support Automotive Industry Trends

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Abstract
As Supply Chain Management (SCM) becomes essential to generate competitive advantage, the development of capabilities in cooperation with other supply chain members is a premise for success. The goal of this paper is to analyze the role these SCM capabilities play in automotive industry supply chains. The paper offers first a study based in the literature and in interviews regarding trends in the automotive industry, SCM capabilities and their co-relation, which resulted in a formal definition for SCM capability. Then a case study in a European Vehicle Manufacturer is presented and discussed. The case study was conducted with three supply chains embracing, among other significant members, 3 vehicle plants and 2 supplier parks located in Western Europe and in South Africa. Within the case study, we analyze how the SCM capabilities are related to the vehicle manufacturer strategic goals and correlate the trends with the capabilities developed within the three supply chains. The analysis allowed us to conclude that the SCM capabilities identified by the study constitute a response to support trends in the automotive industry, as they intend to bring advantages that obey a new logic in competition based on chains. As a spin off of the research, it was also possible to identify that SCM is still limited to the immediate chain of vehicle manufacturers.

Keywords: supply chain management, capabilities, automotive industry, trends

Introduction

It is widely argued in the literature that competition is no longer between organizations, but among these organizations' supply chains (for instance: Lambert et al., 1998; Rice and

Hoppe, 2001; Pires, 2004; Li et al., 2005). Increasing competition has forced manufacturers to go beyond their own factory gates and search for improvements in the interaction with their suppliers and customers along their supply chains. This new logic in competition, based on supply chains, has inspired the appearance of Supply Chain Management (SCM).

SCM is defined by the Global Supply Chain Forum as the integration of key business processes from end user through original suppliers that provide products, services and information that add value for customers and other stakeholders (Lambert et al., 1998). SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities and it includes coordination and collaboration with channel partners (CSCMP, 2006).

One of the critical issues concerning SCM is the development of SCM capabilities that allow activities and processes to be integrated, throughout the supply chain, adapting suppliers and customers to the new logic in competition and providing competitive advantage (Lummus et al., 1998; Rice and Hoppe, 2001). Differently from a capability developed within a single company, the SCM capability is developed in cooperation between different supply chain members to build up together an integrated approach to design, organize, and execute supply chain activities. This does not mean ownership or even direct control, but it does imply mechanisms that influence decision-making and impact system-wide performance (Vonderembse et al., 2006).

In spite of the importance of the topic, the literature lacks a precise and standard definition for the notion of capability (Duysters and Hagedoorn, 2000; Hafeez et al., 2002). Therefore, one of the contributions of our paper is the analysis of existing definitions for capability and to use them as the springboard toward a precise and standard definition for SCM capability.

The main goal of the paper is to analyze the role of SCM capabilities in the automotive industry as a result of the major trends that impact this industry's supply chains. The automotive industry was chosen as it has been very active in the development and introduction of new production systems and management concepts worldwide. Therefore, it is presently developing and introducing capabilities in its supply chains stimulating other industries to do the same.

The rest of the paper is organized as follows. The next section describes the methodology adopted in this research. The third section presents the main trends that have been impacting the management of supply chains in the automotive industry. The fourth section introduces SCM capabilities and correlates them to the automotive trends. The fifth section presents the case study results and the last section offers our final thoughts and main conclusions on the subject.

Research Methodology

The methodology approach consists of two main parts. The first part is a study regarding trends and SCM capabilities in the automotive study and second is a case study.

In the first part we conducted initially non-structured interviews with six specialists and consultants who have been working in the automotive industry for many years, each interview lasting between two and three hours. The results allowed us to unravel and group this industry's main trends and SCM capabilities. These results were corroborated by an exploratory study based in the existing literature. This exploratory study identified the relation between these trends and SCM capabilities and was validated in a second round of interviews with the same group of specialists and consultants mentioned before.

In the second part of the research, we adopted an exploratory case study (Yin, 1994) to investigate the association between the identified trends and the strategic goals of an OEM (Original Equipment Manufacturer) regarding its supply chains to analyze how SCM capabilities are related to the goals. The case study embraced three supply chains of a same vehicle model. To gather secondary data we used internal documents from the OEM, European Automotive Associations reports, and press releases. To collect primary data from each supply chain we conducted:

- Direct observations at three vehicle manufacturer plants (two in Europe and one in Africa) and at two supplier parks (one in Europe and one in Africa); and
- Semi-structured and structured interviews with twelve respondents: five were SCM consultants involved in the OEM's projects; and seven were high-ranked managers and directors who have been working for the OEM for many years in different assignments (logistics, production planning, control and quality, and marketing).

The case study interviews were based on a questionnaire divided into three parts. The first part embraced closed questions and identified the supply chains structure and the SCM capabilities. The second part quantified the intensity of the SCM capabilities developed between the OEM and each of its relevant supply chain members in the three analyzed chains. The third and last part obtained general input concerning the OEM strategies regarding at the chosen supply chains.

Trends in the Automotive Industry

This section presents the major trends that have been impacting the management of supply chains in the automotive industry. The main trends identified in our research were: business orientation change in the supply chain; globalization; outsourcing; rationalization and the reduction in the number of suppliers; development of new materials; shortening of life span of vehicle models; increase of product variety; and adoption of world platforms. Each trend is briefly presented next.

Business orientation change in the supply chain

The automotive industry has been undergoing major changes in business orientation as far as the supply chains are concerned. It is now becoming apparent that the current 'stock-push' vehicle supply orientation in the automotive industry by fulfilling the large

majority of orders from existing stock is no longer a viable proposition (Holweg and Miemczyk, 2003). With the trend of mass customization and personalization, more and more cars are being made through build-to-order (BTO) supply chains, which allows each customer to configure a final product from a personalized subset of components which may be ordered (Krajewski et al., 2005).

Globalization

We share Hill's (1998) understanding of globalization, according to which the term refers to changes toward a more integrated and interdependent world, where commerce, finance, markets, and production are not locally outlined anymore. The automotive industry is nowadays widely regarded as one of the 'most global' industries (Schlie and Yip, 2000). In the automotive industry, globalization has been strongly influenced by the saturation of markets in the triad region (Western Europe, Japan, and North America) and by the potential of growth of markets in developing countries (Humphrey et al., 2000). Hong and Holweg (2005) present the relative growth of the car production in emerging countries compared to the Triad region (Europe; Japan; U.S.A. and Canada). While the global production enlarged from 26.5 million units in 1971 to 41.8 million in 2003 (approximately 63.4%), more than half of this growth was accounted for by emerging countries, which production increased by a factor of seven over the period analysed.

Outsourcing

Outsourcing is a practice in which part of the set of products and services used by a business organization is executed by another business organization, in a cooperative and interdependent relationship. Outsourcing means an option for a relationship that involves partnership and complicity with one or more suppliers in the supply chain, which is comprehensive and difficult to be reversed (Pires, 1998). Such a trend directly influences the sharing of responsibilities executed by members of the supply chain in the automotive industry, where OEMs have been transferring several activities that were traditionally their own to some of their first tier suppliers (Collins et al., 1997; Arbix and Zilbovicius, 1997; Pfaffmann and Stephan, 2001; Smock, 2001). This outsourcing is justified by lower costs and higher quality, and at the same time every company can use its resources in the areas it has technical expertise (Gao et al., 2000).

According to the European Association of Automotive Suppliers (CLEPA), the added value of suppliers in the automotive business went from US$ 496 billion in 1988 to US$ 958 billion in 1998, an increase that reflects the practice of outsourcing in its majority (Gormezano, 2000). The percentage of value creation at the suppliers will continue to rise. The Fraunhofer/Mercer study (2004) estimates the growth to continue from 65% of the total vehicle value built at the suppliers in 2002 towards a 77% in 2015. The suppliers' share in product development is estimated to grow even faster from 30% in 2000 to 50% in 2010 (Dudenhöffer and Büttner, 2003).

Rationalization and reduction in the number of suppliers

The trend to rationalize and reduce the number of suppliers is also present in the automotive industry (Collins et al., 1997). It has been driven by the reduction in the number of suppliers in the first tier of OEMs, leading to the establishment of partnerships and a high level of cooperation between these chain members (Bidault and Butler, 1995; Gao et al., 2000; Corrêa, 2001) and adding value to the extra functions and activities assigned to the suppliers (Pilorusso, 1997; Pires, 1998). Another reason for the mentioned rationalization and reduction is the opening of world markets, making local companies with few technological and financial resources face competition with big multinationals and cease to be independently viable in developing countries.

Other trends

There are also other trends that have been impacting supply chains in the automotive industry. The development of new materials has emerged as a trend to meet rowing environmental, safety and cost constraints, which are stricter each day (Davies, 2003). The use of world platforms has been largely adopted by OEMs to capitalize on the benefits of large scale purchases of common parts and on time and cost reductions that are correlated with vehicle design. Several models share a single project design, instead of having one project for each model of each make (Muffato, 1999). This strategy has allowed OEMs to separate the industrial variety of auto-parts and components from the commercial variety of models offered to the final customers. Another trend that has highly impacted the supply chain in the automotive industry variety is the shortening of life span of vehicle models (Holweg and Greednwood, 2001). BMW, for instance, is planning to introduce an average of 3.7 new models per year until 2010. In the seventies the average was 0.7 new models a year. The product life cycle was constantly shortening from a 9-year cycle in 1990 to less than 7 years today. Most other OEMs have a similar increase in products and shortening life cycles (Software Forum Bayern, 2003). Another key trend in the automotive industry is the increase in offer by OEMs in variant numbers and options for individual models (Seidel et al., 2005). Pil and Holweg (2004), for instance, identified a group formed by BMW and Mercedes models whose total variations factory fitted surpassed the order of 10E16, reaching the order of 10E24 for Mercedes' Class E model.

SCM Capabilities

The existing literature offers different definitions and interpretations for the notion of capability. This section aims toward offering a precise and standard definition for SCM capability.

Capability is a set of actions that the assets of an organization or business use to create, produce, and commercialize a product (Sanchez et al., 1996). According to Day (1994), capability is a complex set of abilities and co-shared learning experiences that guarantee

strategic relevance to the coordination of functional activities whenever it involves maintenance of competitive advantages within an organization. Hafeez et al. (2002), however, define capability as the ability to use resources to perform a task or activity. For these authors, capability derives from the coordination and integration of activities and processes and is the product of a co-shared learning experience in the uses of a business' assets. Hayes et al. (1996) make a difference between ability and capability. The first is simply an indication that a person or organization is capable of doing something, regardless of how efficiently or perfectly, aspects embraced by capabilities. Klein et al. (1998) and Hafeez et al. (2002) highlight the subtle difference between capability and competence. In their point of view, competencies are formed by a set of capabilities, not restraining themselves to a single capability.

Based on the literature, this study advances the following definition for the notion of capability as being a set of actions that use the assets of an organization to create, produce, and commercialise a product (Sanchez et al., 1996), providing customers with an essential benefit. It derives from the coordination and integration of the organization's activities (Haffez et al., 2002; Stalk et al., 1992; Day, 1994), the conjugation of the technologies adopted by this organization (Mazzilli and Wilk, 1997), and the management of its human resources (Day, 1994).

The definition of SCM capabilities that this study adopts takes the aforementioned definition of capability and adapts it to the new logic in competition. Consequently, the term "organization" gives place to "supply chain" and the term "customer" gives place to "final customer," to emphasize that we mean the customer of the chain and not the direct customer of an organization. Thus, management of relationship among members of the chain becomes one more element in the construal of these capabilities. As a result, to face this new paradigm organizations need to intensify their relationship. This study adds these understandings to the definition of SCM capability, which thereafter reads as being a set of actions that use the assets of a supply chain to create, produce, and commercialise a product, providing final customers with an essential benefit. It derives from the coordination and integration of activities and processes in a supply chain, the conjugation of technologies adopted by the chain, the management of its human resources and of relations among members of the chain.

The SCM capability should be developed at least by two entities that establish a supply chain link. Not all links throughout the supply chain should be closely coordinated and integrated (Lambert and Cooper, 2000), what means that there should be different capabilities being developed among the different links. Determining which parts of the supply chain deserve management attention must be weighed against capabilities and the importance to the firm (Lambert and Cooper, 2000).

The literature offers many ways to categorize SCM capabilities, for instance see Evans and Danks (1998) and Min and Keebler (2001). We follow Rice and Hoppe (2001), categorizing SCM

capabilities as techniques, practices, policies, and systems. Examples of SCM capabilities that they identified include ESI (Early Supplier Involvement), JIT (Just in Time), postponement, supplier park, and VMI (Vendor Managed Inventory). Lummus et al. (1998) and Howard et al. (2006) also adopt this form of categorization to refer to JIT as a SCM capability.

Based on the definition we put forward, on the interviews conducted with specialists and on the literature review, the main SCM capabilities that have been developed in the automotive industry considered in our research were: Concurrent Engineering, Co-Design[1], Early Supplier Involvement (ESI)[2], e-Business (e-Commerce and e-Procurement), Follow Design (or Carry Over)[3], Follow Sourcing[4], Global Sourcing, In Plant Representatives (IPR)[5], Just-in-time (JIT), Just-in-Sequence (JIS), Milk Run, Modularisation, Supplier Park[6], Postponement, Quick Response[7], and Vender Managed Inventory (VMI). Table 1 summarizes the correlation among theses capabilities and the main trends acting in the automotive industry.

Case Study

The vehicle manufacturer chosen for the case study is European and produces cars for the luxurious market segment. The current strategies for this OEM supply chains originated from automotive market changes at the end of the 80's, when newcomers joined the luxurious market segment. In this period of time, Honda, Toyota and Nissan introduced their sophisticated and highly valued brands, respectively Acura, Lexus and Infiniti. In the beginning of the 90's, the vehicle manufacturer of this case study noticed that it was not immune to the competition from the Japanese newcomers. The Japanese highly valued brands were already with a significant market share in the luxurious vehicle segment of the American market. This fact, associated with the market share decrease of the OEM, influenced the establishment of the following strategic goals:

- develop and implement a BTO program;
- expand the production activities worldwide;
- increase the frequency of introduction of new models; and
- increase the quality of recently launched vehicles.

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[1] Joint design and execution of plans for a product or component by means of a partnership between the manufacturer and its suppliers (De Toni and Nassimbeni, 2001).

[2] This implies in choosing a supplier before or during the design of a project for a specific product, as well as its involvement in the phases of product development (Dowlatshahi, 1998).

[3] It demands that suppliers, when manufacturing parts, follow the same specifications and attributes in the original project in several countries where the vehicle manufacturer operates (Salerno et al., 1998).

[4] Suppliers move with manufacturers to the new region where vehicles will be produced, building new plants in the region or supplying with its plants already established in the area (Salerno et al., 1998).

[5] When there are representative of a business organization who perform in the facilities of another business.

[6] Parks that concentrate suppliers in one location adjacent to assembly plants (Wright et al., 1998).

[7] A system used to replenish inventory based on real sales information passed on to suppliers (Mentzer, 2001).

Table 1 – Correlating trends with SCM capabilities in the automotive industry.

SCM capabilities	Trends				
	Push => pull	Globalization	Outsourcing	Reduction in the number of suppliers	Other trends
Co-design	Agrawal et al. (2001)	Dias and Salerno (1998)			Medina and Naveiro, (2000)
Early supplier involvement (ESI)	Agrawal et al. (2001)	Gormezano (2000)		Bidault and Butler (1995)	Bidault and Bulter, (1995), Hayes and Pisano (1996), Freyssenet and Lung (2000), Medina and Naveiro (2000), Wynstra et al. (2001)
E-business	Helper and MacDuffie (2000), Agrawal et al.(2001), Gunasekaran and Nagai (2005)	Pires and Musetti (2000) , Smock (2001)			Ratnasingam (2003)
Follow design		Gormezano (2000), Humphrey and Salerno (2000)			
Follow sourcing		Dias and Salerno (1998), Amato Neto and D´Angelo (2000), Lung (2000), Humphrey and Salerno (2000)	Lung (2000)		
Global sourcing		Dias and Salerno (1998), Lung (2000), Freyssenet and Lung (2000), Pfaffmann and Stephan (2001)			
In plant representatives				Pires (2004)	
Just-in-time	Agrawal et al. (2001), Alford et al. (2000), Gunasekaran and Nagai (2005), Howard et al. (2006)	Dias and Salerno (1998)			
Just-in-sequence		Dias and Salerno (1998)	Morris et al. (2004)		
Milk-run	Corrêa and Nogueira (2001)				

Table 1 – Continued...

SCM capabilities	Trends				
	Push => pull	Globalization	Outsourcing	Reduction in the number of suppliers	Other trends
Modularisation	Helper and MacDuffie (2000), Agrawal et al (2001), Alford et al. (2000)	Dias and Salerno (1998), Humphrey and Salerno (2000)	Collins et al. (1997), Arbix and Zilbovicius (1997), Corrêa (2001), Pfaffmann and Stephan (2001), Morris et al. (2004)	Pilorusso (1997), Salerno et al. (1998)	Hayes and Pisano (1996), Pricewaterhouse-Coopers (2002), Seidel et al. (2005)
Supplier park	Alford et al. (2000), Howard et al. (2006)	Wright et al. (1998), Dias and Salerno (1998), Amato Neto and D´Angelo (2000), Humphrey et al. (2000)	Collins et al.(1997), Arbix and Zilbovicius (1997), Dias and Salerno (1998), Lung (2000), Corrêa (2001), Cullen (2002), Morris et al. (2004), Howard et al. (2006)	Collins et al. (1997), Corrêa (2001)	Howard et al. (2006)
Postponement	Gunasekaran and Nagai (2005), Howard et al. (2006)				van Hoek et al. (1999)
Quick Response (QR)	Corrêa and Nogueira (2001)				
Vendor managed invetory (VMI)	Cohen et al. (2000), Corrêa and Nogueira (2001)				

The case study associates the trends presented before to these strategic goals regarding three supply chains that produce a same vehicle module. Within this association, we analyzed how the SCM capabilities are related to each strategic goal.

The first supply chain has as its focal member a Completely Build Up (CBU) plant located in Western Europe (Plant A). Plant A is the OEM's oldest plant and is located inside a big urban center, which brings many restrictions to the management of its supply chain. This plant produces two body type[8] variations of the chosen vehicle Model.

The second supply chain has as its focal member another CBU plant also located in Western Europe (Plant B). Plant B was designed to be more flexible than Plant A, consequently it produces five body type variations of the vehicle model. This supply chain embraces a supplier park nearby Plant B (here called Supplier Park I) that assembles auto parts in sequence for Plant B. Supplier Park I was established in the late 80's and hosts many auto-part companies that belong to the OEM first tier of suppliers. Supplier Park I

[8] The main body types are: sedan/saloon, hatchback, convertible, coupe, and station wagon.

also serves as the European consolidation and distribution center that provides auto parts to the OEM's vehicles assembly plants worldwide.

The third supply chain has as its focal member a plant located in South Africa (Plant C). Plant C assembled, in the past, many different vehicle models, but in a reduced scale. To increase its production scale and to become an important exporter for non-European Markets, Plant C has moved away from assembling Completely Knocked Down (CKD) vehicles models to produce CBU vehicle based on just one model. Supplier Park I also takes part in this supply chain and serves as a consolidation and distribution center for auto parts produced in Europe that will be exported to South Africa. There is also a brand new supplier park in this supply chain (labeled Supplier Park II). This park is located nearby Plant C and should host many first tier and second tier suppliers.

Results

Table 2 displays the results obtained for the case study. The first column displays the main SCM capabilities developed in the automotive industry. The subsequent columns display the relevant supply chain members of the three supply chains analyzed. The case study grouped the supply chain members according to plants A, B and C as follows:

- Upstream members: Member I: module suppliers (tier 1); Member II: highly valued component suppliers (tier 1); Member III: main suppliers of Member I (tier 2); Member IV: supply chain members not considered critic; Member V: in the supply chain of Plant A, this member encompasses an OEM's engine plant, in the supply chain of Plant B, this member encompasses the engine plant and Supplier Park I; in the supply chain of Plant C, this member is Supplier Park I; and
- Downstream members: Member VI: Dealers; and Member VII: End-customers.

The values displayed in Table 2 represent how intensively the SCM capabilities are developed within the supply chain links of plants B and C. A scale ranging from one to five represents the intensity, where five indicates that the SCM capability is largely developed within the related link and one represents that this SCM capability is not developed at all. The SCM capabilities highly developed in the supply chains are highlighted in dark gray. The SCM capabilities that are modestly developed are highlighted in light gray. The SCM capabilities that are not developed are not highlighted. The supply chain links that do not have a direct relation with a SCM capability are represented in Table 2 by a hyphen.

The results presented in Table 2 allowed us to know which SCM capabilities have been present, how intense and in which supply chain links they have been developed. The main links are the ones that embrace the OEM's plants and their supply chain members from the first tier (downstream and upstream).

Table 2 – SCM capabilities developed in supply chains.

SCM capabilities	Supply chain relevant members of plant A							Supply chain relevant members of plant B							Supply chain relevant members of plant C						
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
Modularization	5.0	3.5	1.7	1.7	5.0	-	-	5.0	3.5	1.7	1.7	5.0	-	-	3.0	2.0	1.0	1.0	3.0	-	-
Just in time	5.0	4.0	1.7	2.3	5.0	-	-	4.3	4.0	-	2.3	5.0	-	-	2.5	2.2	-	1.0	-	-	-
Just in sequence	4.5	4.0	-	1.8	4.5	-	-	5.0	4.0	-	1.8	5.0	-	-	1.8	1.8	-	1.0	-	-	-
Milk run	1.0	3.0	-	2.0	-	-	-	1.0	3.0	-	2.0	-	-	-	2.0	2.0	-	1.0	-	-	-
Supplier park	1.0	1.0	1.5	1.5	-	-	-	3.5	3.0	1.5	1.5	-	-	-	1.0	1.0	1.0	1.0	-	-	-
Global sourcing	2.5	2.5			-	-	-	2.5	2.5			-	-	-	-	-	-	-	-	-	-
Follow sourcing			2.0	2.0	-	-	-			2.0	2.0	-	-	-	4.0	4.0	1.5	1.5	-	-	-
Postponement	-	-	-	-	-	1.0	-	-	-	-	-	-	1.0	-	-	-	-	-	-	1.0	-
e-Business	4.0	3.0	1.5	2.5	-	5.0	4.3	4.0	3.0	1.5	2.5	-	5.0	4.3	1.8	1.5	1.0	1.0	-	3.0	2.3
Co-design	5.0	4.0	2.0	2.2	-	-	-	5.0	4.0	2.0	2.2	-	-	-	-	-	-	-	-	-	-
ESI	5.0	4.0	2.0	2.2	-	-	-	5.0	4.0	2.0	2.2	-	-	-	-	-	-	-	-	-	-
Quick response	-	-	-	-	-	3.0	-	-	-	-	-	-	3.0	-	-	-	-	-	-	1.0	-
VMI	2.0	1.0	-	1.0	5.0	2.0	-	2.0	1.0	-	1.0	5.0	2.0	-	1.0	1.0	-	1.0	3.5	1.0	-
IPR	2.0	1.0	-	1.0	-	-	-	1.0	1.0	-	1.0	-	-	-	1.0	1.0	-	1.0	-	-	-

SCM Analysis for the Supply Chains

The analysis is organized according to the following strategic goals: develop and implement a BTO program; expand the production activities worldwide; increase the frequency of introduction of new models; and increase the quality of recently launched vehicles. These goals respond to different trends that impact the automotive industry supply chains and to achieve the goals, SCM capabilities have been developed in different supply chain links, as discussed next.

BTO approach

The strategic goal of developing a BTO program responds to the new business orientation in the supply chain and to the product variety increase trends. The program consists of offering a wide option of choices to end customers to allow them to have customized BTO vehicles. According to the OEM, it is impossible to develop this program without considering other supply chain members. Therefore, the OEM aims to get closer to its upstream and downstream supply chain links.

The OEM has been developing SCM capabilities in the upstream links of its assembly plants, which makes its supply chains flexible to meet a customized order within a pre-established short timing and to allow changes in the purchase order only a few days before the vehicle is delivered to the end customer.

The OEM emphasized the importance of continuously increasing the modules in its vehicles final assembly line for the achievement of the necessary flexibility to execute the BTO program. The responsibility of assembling the modules is given to their suppliers, with very few exceptions, for instance the supply of engines, whose responsibility belongs to OEM. Modularization is a capability well developed in the supply chains of plants A and B.

To make the OEM's final assembly lines more flexible, the modules should feed these assembly lines according to the order of needs for customized vehicles. As the modules are generally highly voluminous, valued and customized, they are not usually stocked in the OEM's plants. Therefore, the development of the Just-in-Sequence (JIS) capability is necessary. Table 2 indicates that this SCM capability is well developed in the module suppliers (member I) for the supply chains of plant A and B. As modularization and JIS, JIT and e-business are also present in the link formed by module suppliers and the OEM.

The modularization, JIS, JIT and e-business SCM capabilities have also been developed in the supply chain links that contain highly valued component suppliers of the first tier (member II) for plants A and B. However, as displayed in Table 2, the development of these capabilities in these links is not as intense as it is for the link that embraces the module suppliers (member I) and the OEM.

E-business has been well developed in all downstream links of plant A and B, both with the dealers and with the end-customers and is not well developed in the supply chain of Plant C, where the developmental stage of SCM is still incipient.

SCM analysis within a worldwide expansion approach to production activities

The goal of expanding production activities worldwide is associated to the globalization trend in the automotive industry. This influenced the production of CBU vehicles in South Africa at Plant C. The change in Plant C from being a CKD assembly plant to a CBU production plant has brought deep transformations to its supply chain, now in an initial developmental stage of SCM. The poor development of SCM capabilities makes the development of SCM in the supply chain of Plant C difficult. Supplier Park II responds to the necessity to improve the SCM of Plant C in such a way that it will become possible for this supply chain to compete globally supporting the vehicle production expansion goal. Such improvement reflects on the need to establish SCM capabilities, mainly ones that concern logistics, for instance JIT and JIS, capabilities that are weakly developed in this chain (see Table 2). To do so, Supplier Park II should host first and second tier suppliers.

Follow sourcing was pointed out as being very relevant for OEM in the links that connect Plant C with their module suppliers (member I) and with highly valued component suppliers of Tier 1 (member II).

Other strategic goals

The other two strategic goals are quality improvement of recently launched vehicles and increase of new models introduction frequency. These goals are related to trends such as outsourcing, reduction in the number of suppliers and reduction in the life cycle of vehicle models. These goals depend on the management of OEM upstream connections, as Hayes and Pisano (1996) have highlighted in their work, suggesting a great proximity with supply chain members, mainly the ones involved with the Research and Development (R&D) process. This proximity was verified in the supply chains of plants A and B by means

of a huge participation of suppliers in vehicle projects that involve the development of SCM capabilities with these plants, such as Early Supplier Involvement (ESI) and co-design. This is highlighted in Table 2, table that indicates that the ESI and co-design SCM capabilities are strongly developed in the supply chain links that connect plants A and B with its module suppliers (member I) and with its highly valued component suppliers (member II). The answers to the questionnaire corroborate this conclusion by providing evidence for the development of these capabilities, as follows: the selection of the supplier occurs in the early stages of the new product development; the information about new products and their respective processes development (e.g. module, technical implications, costs, time periods, etc) is shared with the suppliers, the information systems of the suppliers are compatible and connected with the ones of the OEM; when the OEM transfers activities to its suppliers, it also transfers its respective activity know-how; the OEM has established formal long-term partnerships within with these suppliers.

Not much can be said about the presence of SCM capabilities in the R&D process of the supply chain of Plant C. Co-design and ESI are not developed in this Supply Chain, as the South African branch of the OEM and its local suppliers (in general subsidiaries of multinational companies) do not play important roles in this process. R&D activities are developed and managed by the companies' headquarters.

The capabilities Milk Run, Postponement, Quick Response, VMI, and IPR were not identified in any of the three analyzed supply chains.

Conclusions

Although the development of SCM capabilities in supply chain links has been considered relevant in the academic literature, there is still a lack of definitions regarding this concept. Therefore, this paper's first contribution was to offer a definition for SCM capability that could be appropriate for the SCM literature and could be used to analyze supply chains of the automotive industry. Based on the offered definition, many SCM capabilities were identified by analyzing the main trends that act upon the supply chains of the automotive industry and their relation with the strategic goals of a European Vehicle Manufacturer. To achieve its goals, this OEM has increased its collaboration with its immediate supply chain members. The supply chains of plants A and B presented many SCM capabilities that are well developed in the links that connect the two assembly plant with the relevant members of their immediate chain, mainly module and highly valued component suppliers. With these capabilities the OEM seeks to achieve three of its four goals. The fourth goal, expanding production activities worldwide, was fundamental for the development of the supply chain structure of Plant C, an assembly plant that is located in an emergent country. Its SCM configuration reflects the transition of Plant C from a CKD manufacturing system to a CBU system in the late 90's and the many restrictions yielded by the incipient level of the automotive industry in this country. There are very few existing signs of SCM capabilities

between the relevant supply chain members of Plant C, with the exception of the links that belong to the OEM internal chain.

The analysis allowed us to conclude that the SCM capabilities identified by the study constitute a response to trends in the automotive industry, as they try to bring about competitive advantages that obey a new logic in competition based on supply chains. The results of the case study lead us to the conclusion that although the three analyzed supply chains target the production of the same vehicle model, they present different SCM capabilities.

The results could also indicate that most SCM capabilities have been developed in the immediate chain of the vehicle manufacturer plants. This demonstrates that the theory of SCM is still far from reaching the total supply chain, being in practice still a philosophy limited to some parts of the chain, normally in the main links established with an OEM (in our research a Vehicle Manufacturer). But today's 1st-tier suppliers will face tomorrow the same problems that the OEMs are facing today. They will be forced to interact closer with their suppliers (2nd-tier under an OEM perspective) in supply chain processes, like logistics, manufacturing, research and development, and supplier and customer relationship management, therefore enhancing the management scope of the supply chain beyond the immediate chain.

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