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11-13 Juin 2003 (Ministère de la Recherche, Paris, France)

EVALUATING FOUR SUPPLY CHAINS IN THE AUTOMOTIVE INDUSTRY BY A SCM ANALYTICAL SCHEMA

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One of the greatest paradigm changes in business management is that business units or individual organizations no longer compete as isolated units or single organizations anymore, but rather as supply chains. If each business unit of the supply chain is acting in a way to optimize its own value, there will be discontinuities at the interfaces and unnecessary costs will result. If an integrated view is taken instead, there may be opportunities in the supply chain where additional expense or time in one segment can save tremendous expense or time in another segment. This is the foundation of supply chain competition logic. Instead of brand versus brand or store versus store, it is now suppliers-brand-store versus suppliers-brand store, or supply chain versus supply chain. In this context, Supply Chain Management (SCM) has been recognized as a new major forefront for effective competition.

The main goal of the present paper is to analyze four supply chains of a European Vehicle Manufacturer using a SCM analytical schema. These four supply chains target the production of the same vehicle model (here called the ß Model), but they present different characteristics that reflect distinct SCM configurations. The analysis of these different configurations is the object of study of the present paper.

The methodology adopted in this research was inspired on the discovery oriented approach adopted in Menon *et al.* (1999) and consists of the following three dimensions: 1) an academic perspective based on secondary data which main goal is to identify and to analyze the theoretical concepts related to the theme; 2) an industrial perspective based on primary data which main goal is to identify and to analyze the practical concepts related to the theme; 3) an perspective based on the authors' knowledge obtained by the analysis of the perspectives mentioned before.

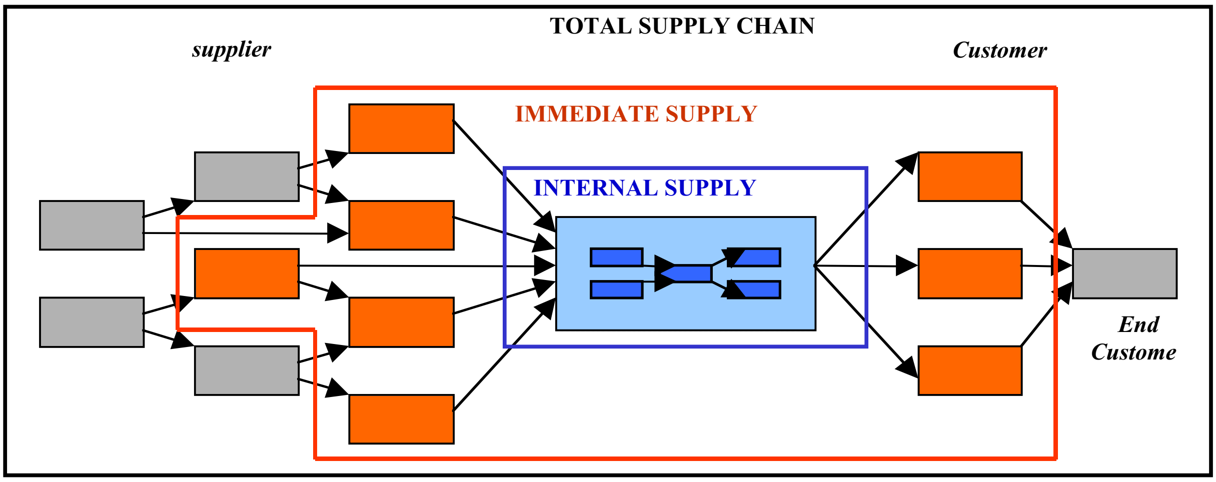
In order to achieve its goal, the paper presents in its second heading a brief literature review concerning the relevant elements for a SCM analysis. The schema for SCM analysis and the way it was applied to the automotive industry are presented respectively in the third and fourth headings. The fifth, sixth and seventh headings present the results of the analytical schema focusing the ß Model supply chains point of view (goal of the present paper). The fifth and sixth heading present relevant elements to the SCM configuration for the four ß Model's supply chains. The seventh heading presents the SCM analysis for the SCM configuration. The last heading presents the main conclusions of this paper.

THEORETICAL BACKGROUND

The term "supply chain" is used variously to refer to the sequence of activities conducted within the organization itself, to the group of suppliers delivering goods and services to the organization, and to both of these, coupled with the organization's customers (Lamming, 2000).

The supply chain can be classified into three levels: internal supply chain, immediate (or direct) supply chain, and total supply chain, as presented in Figure 1 (adapted from Slack, 1992). The internal supply chain consists of departments, cells or operation sectors that are internal to a firm or a business unit, this means a single organization. The immediate supply chain consists of suppliers and customers who are in direct contact with the operation of a single organization. The total supply chain consists of all the supply chains that are involved with a specific product, including the downstream suppliers and the upstream customers of the immediate supply chains.

Figure 1: The internal, immediate and total supply chains



All the firms that participate in a supply chain from raw materials to the ultimate consumer and the links between these firms form the supply chain network structure (Lambert and Cooper, 2000).

In a supply chain competition logic, companies must refocus their efforts away from conventional business units paradigms, centered on transaction management and parochial performance metrics, toward strategies that recognize that to achieve competitive advantage. Companies must work together across enterprise boundaries and should optimize and integrate the supply chain business processes and innovative capabilities that preempt the competition and open whole new areas of competition space (Ross, 1998).

The introduction or consolidation of the SCM philosophy has been essential to achieve a supply chain competitive advantage. The Global Supply Chain Forum defines SCM 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 and Cooper, 2000). The basic objective of SCM is to maximize the synergy among all the parts of the supply chain in order to serve the end costumer more effectively, either by reducing costs or by enhancing value.

SCM can also be understood as an upgraded extended and holistic vision of the traditional material management embracing the entire supply chain in an integrated management approach. It presupposes that companies must redefine their competitive and functional strategies with regard to their position (as suppliers and/or customers) in the supply chain in which they are inserted (Pires 1998).

The integrated and optimised approach of SCM starts in the internal supply chain. It is impossible to integrated and optimised key business processes beyond the four walls of a business unit (firm) if this business unit has not integrated and optimised its processes inside its own organization. This internal integration step has already been largely achieved by many firms worldwide. Handfield and Nichols (1999) argue that now these business units must not only manage their own organizations but also be involved in the management of the upstream and downstream firms of its supply chain. This broader approach is a response to the need to increase the level of performance of these business units, adapting them to supply chain logic. Frohlich and Westbrook (2001) demonstrate empirically that a greater degree of supply chain integration is strongly associated to higher levels of performance. The present paper associates the moving towards more extensive supply chain integration to development stages of SCM.

One of the critical issues in the development of SCM is the development of SCM capabilities that allow activities and processes to be integrated, throughout the supply chain, adapting them to the new logic in competition and providing competitive advantage (Rice and Hoppe, 2001; Lummus *et al.*, 1998). SCM capability is in this paper understood as a set of actions that use the assets of a supply chain to create, produce, and commercialize a product, providing final customers with an essential benefit. It derives from four elements: the coordination and integration of activities and processes in a supply chain, the conjugation of information technologies adopted by the supply chain, the management of its human resources and of external relations among members of the supply chain. These four elements enable the SCM capabilities and are called the SCM enablers (Marien, 2000). A brief explanation of the main SCM capabilities identified in the automotive industry is given next.

Co-Design: Joint design and execution of plans for a product or component introduction by means of a partnership between the manufacturer and its suppliers (De Toni and Nassimbeni, 2000).

E-Commerce: A concept that transfers to the Web the process and management of sales. It implies cost reduction and the establishment of closer and more interactive communication among members of the same supply chain.

E-Procurement: A concept that transfers to the Web the process and management of purchasing and supplying (Smock, 2001). E-procurement implies doing away with paper, a more comprehensive bidding process, and the possibility of monitoring the performance of suppliers closely.

ESI (Early Supplier Involvement): “Early Supplier Involvement,” ESI, implies choosing a supplier before or during the design of a project for a specific product, as well as its involvement in the various phases of product development (Dowlatshahi, 1998). The implementation of ESI improves product quality, reduces product development time and its correspondent costs (Bidault & Butler, 1995).

Follow Design: “Follow Design”, also known as “carry over,” implies using the same project of a product in several countries where the auto-manufacturer operates; or else, it demands that suppliers, when manufacturing parts, follow the same specifications and attributes in the original project (Salerno *et al*., 1998).

Follow sourcing: In “Follow sourcing” suppliers move with manufacturers to the new region where vehicles will be produced. The supplier may build new plants in the region or supply the manufacturer using its plants that are already established in the area (Salerno *et al*., 1998).

Global sourcing: A notion that involves searching for suppliers worldwide without considering their geographical or national location (Salerno *et al*., 1998).

IPR (In Plant Representatives): IPR are representatives of a business who perform in the facilities of other businesses. These representatives can work together with customers or suppliers, aiming at guaranteeing that they meet their own needs more efficiently.

JIT (Just-in-time): A Japanese method of material administration that tries to organize supply deliveries according to the dates on which materials will be necessary in the line of production. Its objective is to achieve zero idle inventory (Bowersox & Closs, 1996). That is, in each phase of the process, parts are produced to meet the needs of demand in the next phase.

JIS (Just-in-Sequence): JIT is a special case of JIT. It involves sequencing the supply of a part according to the correct order in which it will enter the final assembly line of a vehicle. It is adopted for highly customized parts, as for example, seats, coverings, door modules, etc., because they need to be delivered in sequence, according to the corresponding order of production (Dias e Salerno, 1998).

Milk Run: A method for obtaining parts daily. In this method, car manufacturers hire logistic operators to go to suppliers and pick up parts. A truck, at a specific time, stops by several suppliers located in the surroundings, where the negotiated parts should be available. This method avoids high levels of inventory of a same part (Salerno *et al.,* 1998).

Modularisation: Modularisation involves assembling vehicles by putting together several previously assembled sub-sets (the modules). The idea is to simplify the final assembly, aiming at cost reduction, higher efficiency in assembly operations, and a decrease in investments geared to new plants (Alvarez et al., 2002).

Supplier Park: Parks that concentrate suppliers and component manufacturers in one location adjacent to assembly plants (Wright et al., 1998). These parks may be of two types: a modular consortium and an industrial condominium. *Modular Consortium*: A type of Supplier Park in which the product is separated in modules and specific suppliers, also called modulists, become fully responsible for the modules production. The modulist supplier is also responsible for the assembly of the module in the final assembly line at the auto-maker plant. The modulist also holds a long-term partnership with the auto-maker, sharing risks and benefits linked to the production of the respective vehicle (Pires, 1998). *Industrial Condominium*: A type of Supplier Park that involves having suppliers in the auto-maker plant. A series of suppliers settle down in the building of the auto-manufacturer or build plants in the premises of the manufacturer or close to it. Conceptually, the difference between the Industrial Condominium and the Modular Consortium is that the auto-manufacturer has higher added value in the case of the Industrial Condominium (Salerno *et al*., 1998; Pires, 1998; and Arbix and Zilbovicius, 1997).

Postponement: A capability that makes it possible to postpone the differential of a product until consumer's demand for that product becomes known (Lee and Billington, 1995; Mentzer, 2001).

QR (Quick Response): A system used to replenish inventory based on real sales information that is passed on to suppliers (Mentzer, 2001). Although it seems similar to JIT, it focuses on the relation between final customers and retail agents (Smart, 1995).

VMI (Vender Managed Inventory): A modified version of QR in which the supplier does not need to wait for the purchase order from the customer to deliver parts, taking full responsibility for replenishing the customer (Mentzer, 2001). The VMI system makes the supplier the responsible for sustaining and controlling the level of inventory of its customers

SCHEMA FOR SCM ANALYSIS

The present heading presents the schema for SCM analysis. The relevant elements that should be considered in this analysis are organized according to the following key-questions:

- ✓ Key-Question I- ***What*** *influences the SCM development?*
- ✓ Key-Question II- ***Who*** *are the relevant actors (supply chain members) that should be involved in the development and implementation of a SCM?*
- ✓ Key-Question III- ***Which*** *SCM capabilities are developed?*
- ✓ Key-Question IV- ***How*** *are the SCM capabilities enabled?*
- ✓ Key-Question V- ***Where*** *are the SCM capabilities developed and the SCM enablers present in the supply chain network structure (supply chain links)?*
- ✓ Key-Question VI- ***Why*** *does the supply chain have a given SCM configuration?*
- ✓ Key-Question VII- ***When*** *is a given SCM configuration established?*

The SCM relevant elements have implications that are common to the different supply chains that belong to a same industrial segment, and implications that are specific to the chains of the different products that belong to this segment. Therefore, the SCM analysis is primarily done in an industrial segment (IS) and later in selected supply chains of this industrial segment that are the object of study. Thus, the first four steps of the analytical schema regard an industrial segment and the next three steps regard specifically the selected supply chains that belongs to this industrial segment. These first seven steps give the necessary inputs to obtain a SCM configuration for the selected supply chains and to execute successfully the last step of the schema, the step responsible for the SCM analysis itself. Figure 2 illustrates the analytical schema for SCM analysis associating its eight steps with the relevant SCM key-questions.

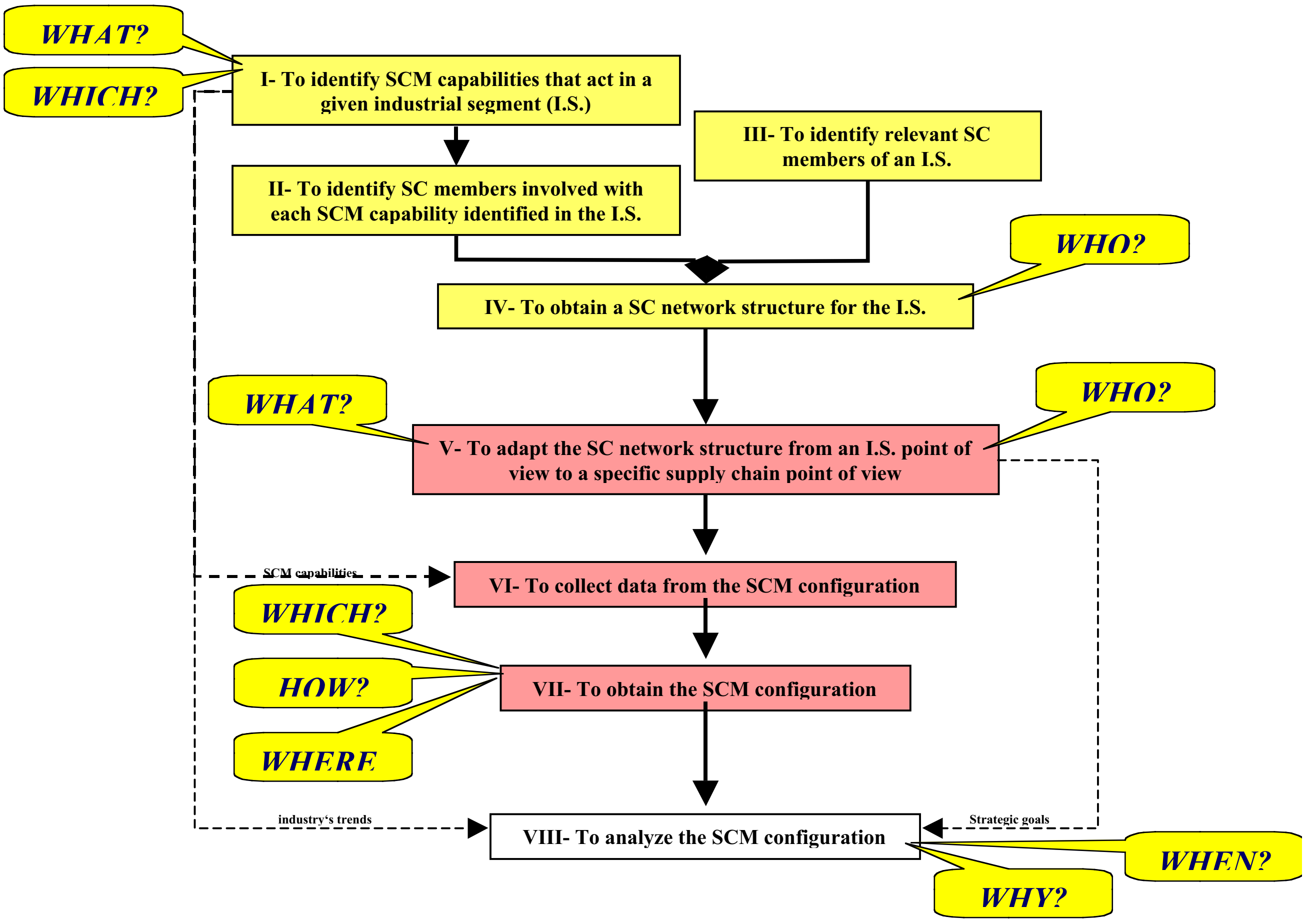


Figure 2: Analytical schema for SCM analysis

The first four steps address three key-questions that regard a given industry segment: what influences the SCM development, who are the actors, and which SCM capabilities have been developed. From fifth step until the eighth step there is a change from an industrial segment point of view to specific supply chains point of view. As the paper's goal regards to this second point of view, the first four steps will not be discussed further in this paper.

The fifth step adapts the supply chain network structure valid for an industrial segment to a structure that considers the particularities of the selected supply chains. This step answers Key-question III (Who are the actors) for these selected supply chains. Parameters like the strategic goals of the members involved, the location of these relevant members, the market they attend, among other information that vary from supply chain to supply chain, should be considered in order to narrow the SCM point of view from an industrial segment perspective to the selected supply chains perspective. These parameters address Key-Question I (What influences the development of the SCM) for the selected supply chains and are important inputs for Step VIII (SCM configuration analysis).

The sixth step targets how the data referent to the SCM configuration should be collected. The seventh step defines how the different data collected should be associated in relation to the

SCM capabilities and to the SCM enablers. Within this association it is possible to answer Key-Question III (Which SCM capabilities have been developed), Key-Question IV (How are these capabilities enabled) and Key-Question V (Where are the SCM capabilities developed and the SCM enablers present).

The eighth step of the schema analyzes the SCM configuration obtained by Step VII, supported by additional information obtained by steps I and V. Step I provides the trends that impact the industrial segment of the selected supply chains and Step V provides strategic goals that regard to these supply chains. This step answers Key-Question VI (Why does the supply chain have a given SCM configuration) for the selected supply chains. This key-question justifies, for instance, the development of certain SCM capabilities in some supply chain links and the absence in others. Within this step it is also possible to figure out the SCM developmental stage of the selected chains (SCM implemented in the internal or immediate or total supply chain), answering Key-Question VI (When is a given SCM configuration established).

APPLICATION OF THE ANALYTICAL SCHEMA FOR SCM ANALYSIS

The present heading describes briefly how the analytical schema was applied to the four supply chains of a vehicle model (here called ß Model) produced by a European Vehicle Manufacturer (here called XYZ).

Step I to Step IV of the schema

First an explanatory study concerning the trends that impact the automotive industry was done to identify the relations between these trends and the SCM capabilities and then the relations between these capabilities and the supply chain members. This explanatory study resulted in an academic perspective for SCM in the automotive industry. An industrial perspective for this same subject was also obtained by non structured interviews with SCM practitioners and experts. As a result of the knowledge of both academic and industrial perspective it was possible to obtain a supply chain network structure composed by the relevant supply chain members.

Step V and VI of the schema

Once again the association between an academic perspective and an industrial perspective combining primary and secondary data was done. The data collection methods used gathered: internal documents from the Vehicle Manufacturer XYZ; journals papers and reports; direct and indirect observations; and non structured and semi-structured interviews with SCM consultants involved in XYZ projects and XYZ employees. This procedure made possible the preparation, validation and application of the case studies that involved the four supply chains for the ß Model. An important part of the case study was the conduction of interviews with XYZ managers and directors. These interviews were based on a questionnaire that was divided into the following three parts:

Part I (closed questions) - Target: to check some key information obtained by the pre-interviews (primary data) and in the literature review (secondary data). The questions verify if the supply chain structure for the ß model obtained by Step V and the SCM capabilities obtained by

Step I are suitable for the second part of the questionnaire; and identify the relevance of the main SCM capabilities.

Part II (closed questions) - Target: to identify how the SCM is being developed and supported in the ß Model supply chains. This part provided the backbone of the SCM capabilities and SCM enablers identification. The sequence of the questions of this part is organized according to XYZ business processes. The following business processes were considered as the main ones for XYZ: manufacturing, logistics, procurement, marketing, and research & development. The questions of this part stated the intensity of the relation between XYZ and each relevant supply chain member of the four ß Model supply chains.

Part III (open questions) - Target: Obtain general inputs concerning XYZ strategies for the ß Model chains. This part is an important input for the SCM analysis done in Step VIII.

Step VII and VIII of the schema

A qualitative analysis took place for the XYZ case studies results due to the fact that a significant part of the data was collected by non-structured and semi structured interviews. The data collected in the structured interviews are quantified, but the sample was not significant for a statistic analysis. This procedure was done according to the decision of conducting interviews with a small number of people, having long, deep, and interactive personal interviews and more reliable answers. The answers of the second part of the questionnaire were classified / tabulated according to their relation to the SCM capabilities and SCM enablers in such a way that it was possible to identify their development in the supply chain links. The application considers three SCM enablers: information technology, process integration and level of external relationship.

As the goal of the present paper concerns to the SCM analysis of the ß model supply chains, the paper will focus its attention on the Key-Questions that regard to these supply chains. The heading entitled "XYZ vehicle manufacturer" addresses the Key-Questions: I- what influences the development of the SCM (What are the strategies regarding the supply chains of XYZ vehicles), and II- who are the actors (Who form the supply chain network structure). The heading that comes next entitled "SCM capabilities and enablers" addresses the Key-Questions: III- which SCM capabilities have been developed, IV- how are these capabilities enabled, and V- where are the SCM capabilities developed and the SCM enablers present. The next heading entitled "SCM analysis for the four ß Model's supply chains" addresses the Key-Questions: VI- why does the supply chain have a given SCM configuration, and VII- when is a given SCM configuration established.

XYZ VEHICLE MANUFACTURER

This heading presents the vehicle manufacturer XYZ and the supply chains for its ß Model based on Step V procedures of the analytical schema. This heading addresses Key-Question I (What influences the development of the SCM) and Key-Question II (Who are the actors). Each of these Key-Questions will be discussed separately in the following subheadings: "Strategies regarding the supply chains of XYZ vehicles"; and "Supply chains of the ß model".

Strategies regarding the supply chains of XYZ vehicles

This subheading addresses Key-question I (what influences the development of the SCM). The main goal here is to obtain the main strategies that regard the supply chains of XYZ vehicles.

XYZ started its industrial activities in the beginning of last century producing engines for airplanes. The vehicle production started on the late 20's with the development of sportive models. XYZ's vehicle production was very low until the middle of last century. At this time XYZ was involved in deep financial problems. The solution for these problems was the creation of a new market segment where XYZ combined the performance of the European sport cars with the style and comfort of the luxurious European sedans. This new combination made XYZ vehicle sells grow significantly during the 60's and 70's. Today XYZ is one of the world's biggest vehicle manufacturers.

At the end of the 80's new comers jointed the luxurious market segment. Honda, Toyota and Nissan introduced in this period their sophisticated and highly valued brands, respectively Acura, Lexus and Infiniti. In the beginning of the 90's XYZ noticed that it was not immune to the competition from these Japanese new comers (Storey, 1997). The Japanese highly valued brands were already with a significant market share in the luxurious vehicle segment of the American market. This was associated to the huge decrease of participation of the European vehicle manufactures in the market share, including XYZ. Within this scenario, XYZ established three strategic goals: to increase the variety of each of its vehicles, to increase the frequency of introduction of new models, and to increase the quality of recently launched vehicles (Hayes et al., 1996).

1. ***To increase the variety of each of its vehicles***: according to XYZ point of view, the end-customers of a luxurious sport vehicle wants, besides comfort, sophistication and performance, a product that is unique. This requires XYZ to develop a vehicle with many variants in order to offer the end-customer a customized vehicle, based on a large number of combinations. To do so, production flexibility through the supply chain is an important issue to be achieved.
2. ***To increase the frequency of introduction of new models***: the life cycle of a XYZ vehicle model in the 80's could reach 10 years. XYZ used to take eight years in average to introduce a completely new model to the market. It took much less time for the Japanese to introduce their new products, what pressured XYZ to introduce its products within a higher frequency. To do so, the reduction in the development time of XYZ products is an important issue to be achieved.
3. ***To increase the quality of recently launched vehicles***: the initial phase of a recently launched vehicle is always considered critic because it is the first time that this vehicle and many of its components are produced in production scales. Before the entrance of the Japanese in the luxurious segment, XYZ models were in a comfortable position when compared to their competitors in relation to their quality during this critic phase of the life cycle of a vehicle model (its market introduction). During the market introduction of a new model the relation of 10 to 15 complains per unit was considered acceptable. Within the 90's Lexus, for instance, had just three to five complains per vehicle during the first year of its market introduction. This pressured XYZ to increase the quality of its recently launched vehicles in order to compete with the Japanese brands.

The integration of XYZ activities with other members of its supply chains is needed in order to achieve these strategic goals. In fact this can be already noticed by a larger participation of auto-part suppliers in XZY business processes, what is discussed in details in Hayes *et al.* (1996).

The present paper adds two more strategic goals to the ones described in Hayes *et al.* (1996). They are: ***to expand the production activities worldwide*** and ***to build to order (BTO).***

The strategic goal of expanding production activities worldwide is added based in Storey (1997) and Bursa *et al.* (1998). This expansion is a direct consequence of the production globalization. XYZ follows this third wave of the globalization process, process described in Warnecke (1993), Baumann (1996) and Fleury (1999), by establishing assembly and production plants worldwide (USA, Latin America, Africa and Asia). XYZ group has also followed the rationalization of vehicle manufacturer trend by acquiring other vehicle manufacturers, aiming mainly an increase in its production scale and in its product mix (Storey, 1997 e Bursa *et al.*, 1998). XYZ has also established research and development (R&D) centers in USA and Japan, which today collaborate with the European R&D center.

The strategic goal of building to order is added based on information obtained with interviews at XYZ. To due so, XYZ have introduced the customer-oriented sales and production process (COSAPP). With this program the dealer or the end-customer is in a position to order the vehicle directly from a database and individually configure it. End-customers are offered a quantum leap in flexibility and a dramatic cut in processing times. COSAPP aims:

- ✓ To respect the vehicle delivery schedules, being the delivery date whenever possible established by the end-customer.
- ✓ To reduce the process time of configuring, scheduling and delivering the vehicle to the end-customer to a maximum period of 10 working days. The delivery periods for vehicles produced abroad or delivered to foreign countries are longer due to longer ways of transport. Deliveries to the United States, for example, may take another three to four weeks awaiting shipment across the Atlantic.
- ✓ To allow the customer to alter his order up to about six days before start the vehicle is delivered. The end-customer can change the engine, color and equipment options and keep the same delivery date.

The successful achievement of this goal depends on the way the supply chains of XYZ are associated and integrated towards a SCM. This means that many other supply chain members should be involved in the COSAPP and the development of SCM capabilities with these members is required. The identification of these capabilities and the understanding of how they support this and the other XYZ strategic goals are important issues that will be addressed later in this paper during the SCM analysis of the ß Model's supply chains.

According to the previous analysis and considering that the strategic goal of building to order with the COSAPP incorporates the Strategic Goal A proposed in Hayes et al. (1996) (to increase the variety of each of XYZ's vehicles), the present paper considers the following strategic goals as being the most relevant goals established by XYZ regarding the supply chain of its vehicles.

- ✓ Strategic goal I: to increase the frequency of introduction of new models.
- ✓ Strategic goal II: to increase the quality of recently launched vehicles.
- ✓ Strategic goal III: to expand the production activities worldwide.
- ✓ Strategic goal IV: to develop and implement the COSAPP (customer-oriented sales and production process).

It is important to remind that all these strategic goals are related to the traditional strategic goals like return on investment (ROI), satisfaction of the stakeholders, among others.

Supply chains of the ß model

This subheading addresses Key-question II (who are the actors). The main goal here is to obtain the relevant members that form the supply chain network structure, object of the analytical schema's Step V.

The schema was applied to the four supply chains of a same vehicle model (here called ß Model) produced by a European Vehicle Manufacturer (here called XYZ). The application used the plants of this Vehicle Manufacturer as the focal member of their respective supply chains.

The first supply chain analyzed has as its focal member a plant located in Europe (Plant A) that has been producing completely build up (CBU) vehicles since the 1960's. Plant A is XYZ oldest plant and is located inside a big urban center, what reflects in many restrictions to the management of its supply chain. This plant produces two variations of the ß Model (Sedan and Compact). Plant A also produces engines that are also used to supply other XYZ plants. Figure 3 presents the network structure for the supply chain of Plant A, where its relevant members are highlighted with a gray background.

The second supply chain analyzed has also as its focal member a CBU plant located in Europe (Plant B). Plant B has been producing since the mid 80's and was designed to be more flexible than Plant A. Due to this reason, Plant B produces five variations of the ß Model (Sedan, Compact, Station wagon, Cabriolet and Sportive Version). Figure 4 presents the network structure for the supply chain of Plant B, where its relevant members are highlighted with a gray background. The main difference of this network structure in comparison with the one for Plant A is the existence of a supplier park (here called Supplier Park I) that assembles some auto parts in sequence for Plant B.

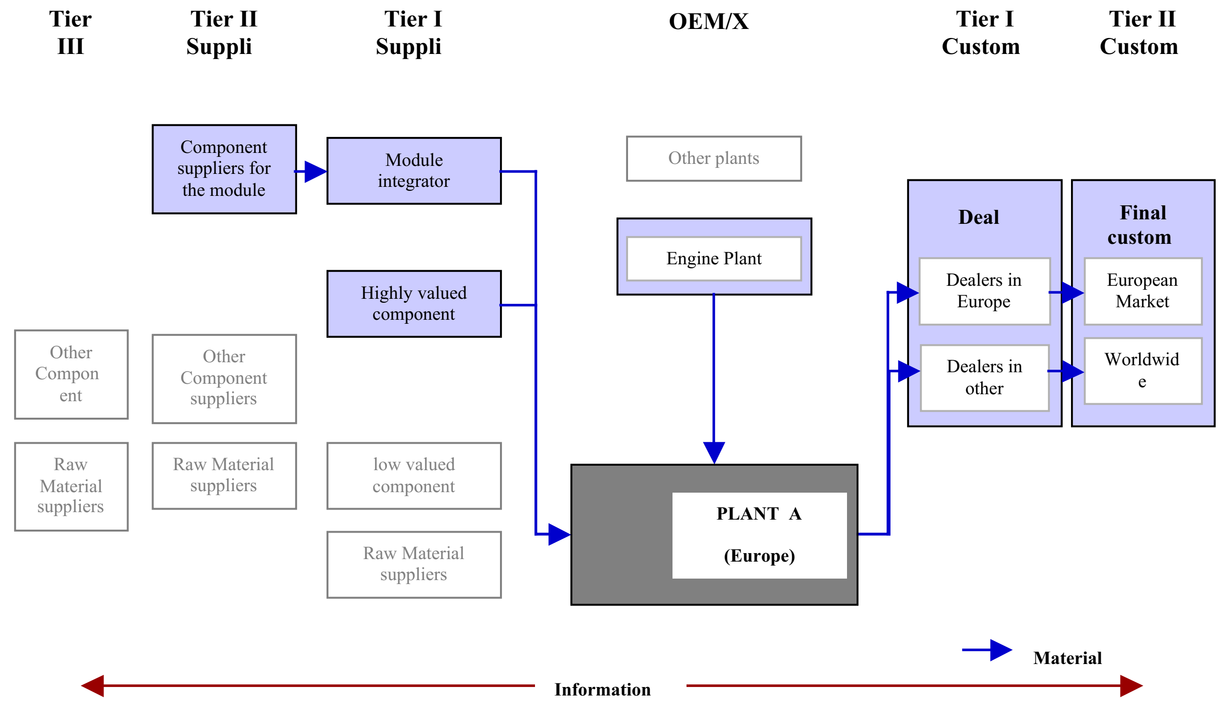


Figure 3: Supply chain network structure for the β Model (focus: Plant A)

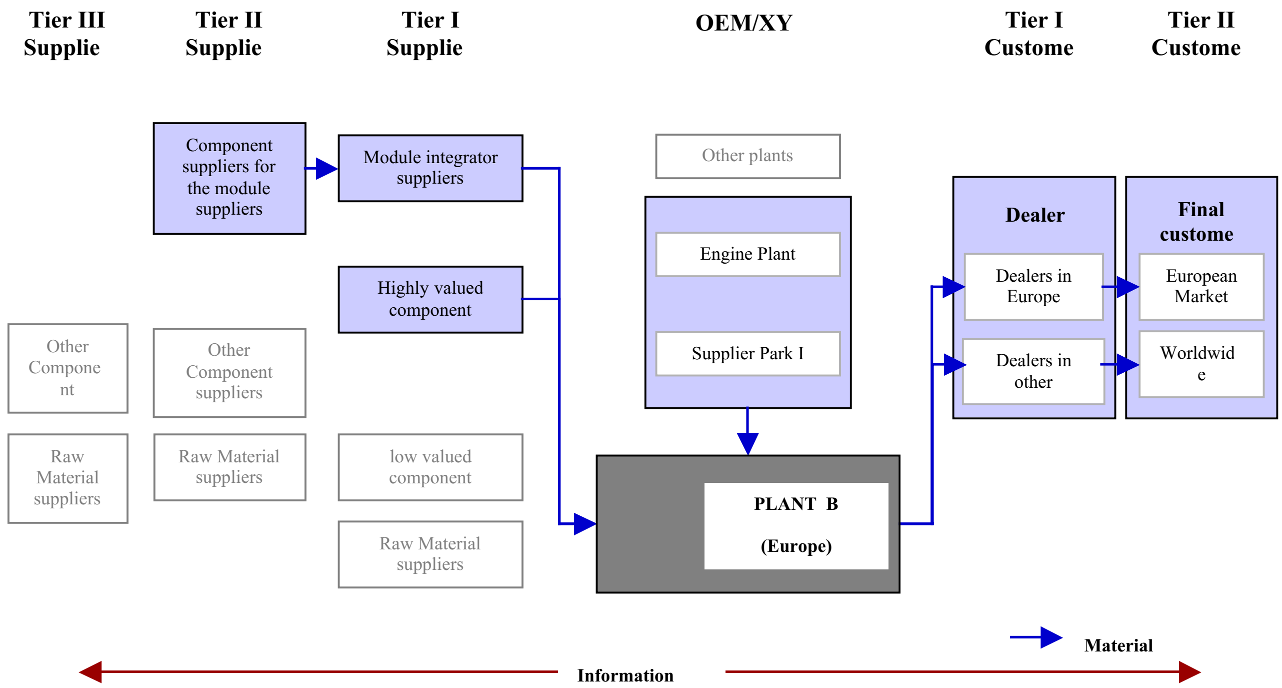


Figure 4: Supply chain network structure for the β Model (focus: Plant B)

Supplier Park I was established in the late 80´s and is located nearby Plant B. It hosts many auto-part companies that belong to the first tier suppliers of XYZ. This supplier park also serves as a consolidation and distribution center for auto parts produced in Europe to XYZ's completely knocked down (CKD) assembly plants located worldwide and CBU production plants located outside Europe.

The third supply chain analyzed has as its focal member a plant located in an emerging country (Plant C). Plant C assembled in the past many XYZ models but in a reduced scale. With the rationalization of its activities, Plant C started to assemble only CKD ß Models, in order to increase its production scale targeting economies of scale and to become an important exporter for non European Markets. Plant C has recently moved its activities from assembling CKD vehicles to producing CBU vehicles. This change is still under way and reflects in deep changes in the supply chain of Plant C that imply in implementation of a SCM. Figure 5 presents the network structure for the supply chain of this plant, where the supply chain relevant members are highlighted with a gray background. Supplier Park I takes part of this network structure serving as a consolidation and distribution center for auto parts produced in Europe. It can also be seen that there is a supplier park under construction (here called Supplier Park II) that will be located nearby Plant C. This supplier park will host first tier and second tier suppliers and should start to work in 2003.

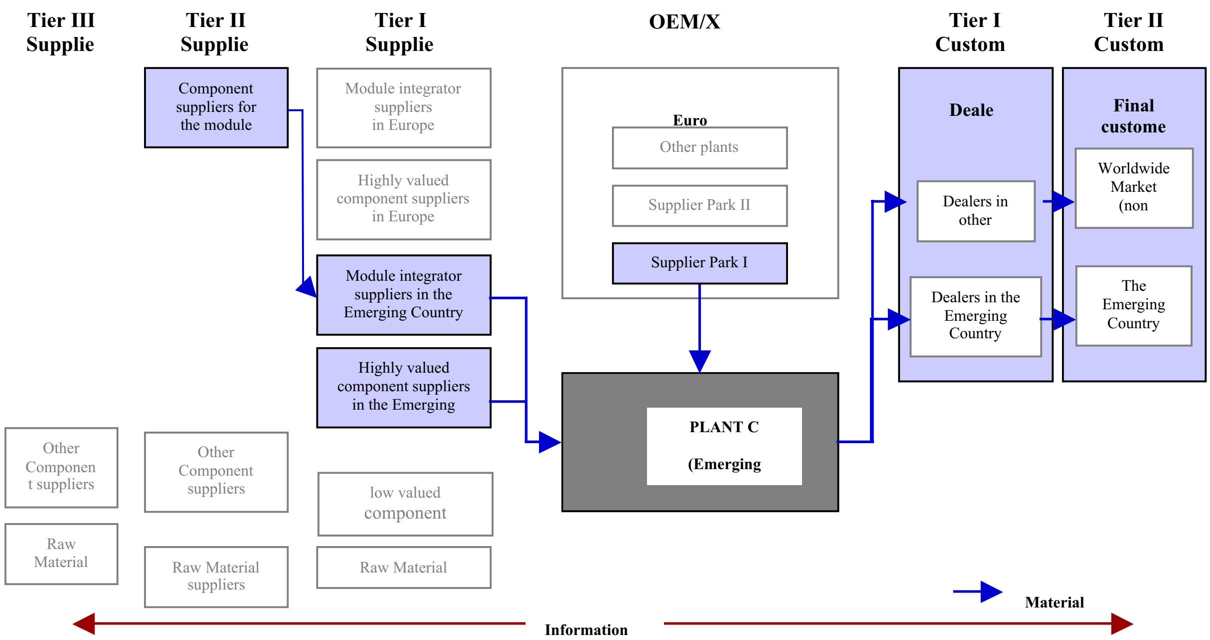


Figure 5: Supply chain network structure for the ß Model (focus: Plant C)

The focal member of the fourth supply chain analyzed is a new plant in Europe (Plant D). This plant will start its production in 2005. Figure 6 presents the network structure for the supply chain of this plant, where the supply chain relevant members are highlighted with a gray background. Supplier Park I takes part of this network structure, as it does in the one for Plant B, but there will be a new supplier park (her called Supplier Park IIII) in the supply chain of Plant D. This supplier park will be located nearby Plant D and will host only module suppliers.

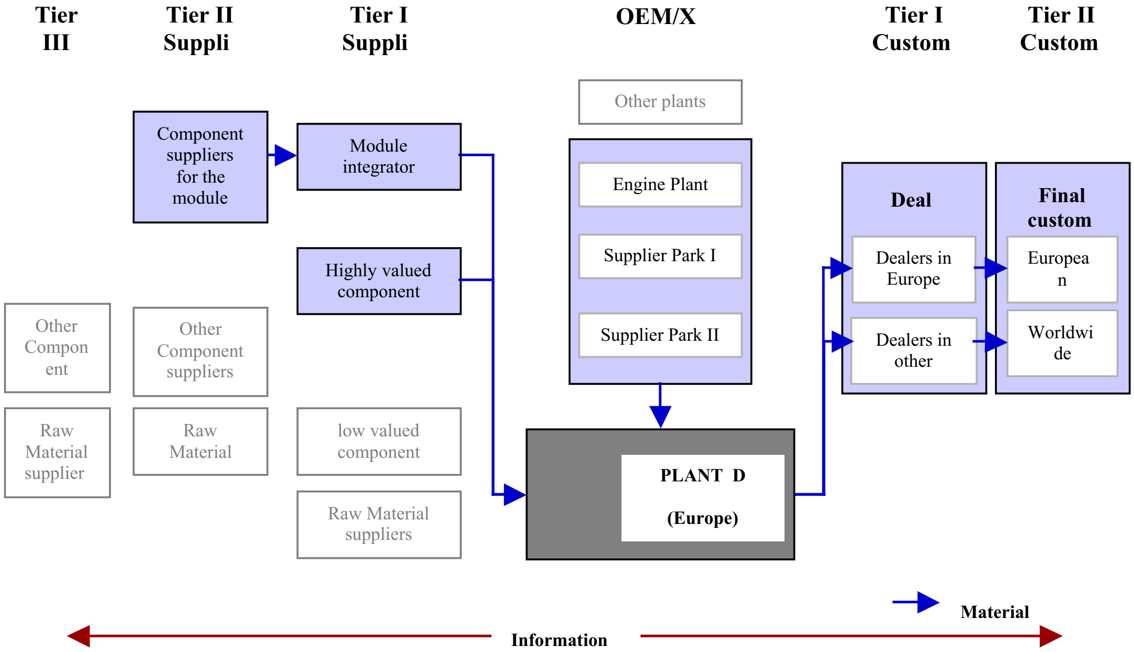


Figure 6: Supply chain network structure for the ß Model (focus: Plant D)

SCM CAPABILITIES AND ENABLERS

This heading presents the SCM configurations obtained with the execution of the sixth and seventh step of the schema for SCM analysis. This heading addresses Key-question III (which SCM capabilities have been developed in the ß Models supply chains); Key-question IV (how are these capabilities enabled); and Key-question V (where are the SCM capabilities developed and the SCM enablers present).

Based on the four supply chain network structures presented on the previous heading of this paper, Table 1 displays the results of the analytical schema regarding the supply chain links where the SCM capabilities are developed. The first column of Table 1 contains the SCM capabilities identified in Step 1 of the schema. The following columns contain the relevant supply chain members of the four ß Model supply chains identified in Step V of the schema, represented in Table 1 by Table 1a, Table 1b, Table 1c, and Table 1d.

Table 1 classifies the supply chain members as: *Member I*: module suppliers (tier 1); *Member II*: highly valued component suppliers (tier 1); *Member III*: suppliers of Member I (tier 2); *Member IV*: all the supply chain members that are not considered critic towards a SCM implementation; *Member V*: in the supply chain of Plant A this member is XYZ's engine plant, in the supply chain of Plant B this member encompasses this engine plant and the Supplier Park I, in the supply chain of Plant C this member is Supplier Park I, and in the supply chain of Plant D, this member is Supplier Park III; *Member VI*: Dealers; and *Member VII*: End-customers.

The values displayed in Table 1 represent how intense the SCM capabilities are developed within the supply chain links of plants A, B, C and D. A scale ranging from one to five represent 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 developed in the supply chains are highlighted with a dark gray background in Tables 1. The SCM capabilities that are modestly developed are highlighted with a light gray background. The SCM capabilities that are not developed are not highlighted. This table uses the term “ANP” (answer not possible) in the links where it was not possible to obtain the development intensity value of a SCM capability. The supply chain links that do not have a direct relation with a SCM capability are represented in Table 1 by a hyphen symbol.

Table 1: SCM capabilities developed in supply chains links

	Table 1a							Table 1b						
SCM Capabilities	Relevant members of the ß Model’s supply chain focused in Plant A							Relevant members of the ß Model’s supply chain focused in Plant B						
	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	-	-
Just in Time	5.0	4.0	1.7	2.3	5.0	-	-	4.3	4.0	-	2.3	5.0	-	-
Just in Sequence	4.5	4.0	-	1.8	4.5	-	-	5.0	4.0	-	1.8	5.0	-	-
Milk Run	1.0	3.0	-	2.0	-	-	-	1.0	3.0	-	2.0	-	-	-
Supplier Park	1.0	1.0	1.5	1.5	-	-	-	3.5	3.0	1.5	1.5	-	-	-
Global Sourcing	2.5	2.5			-	-	-	2.5	2.5			-	-	-
Follow Sourcing			2.0	2.0	-	-	-			2.0	2.0	-	-	-
Postponement	-	-	-	-	-	1.0	-	-	-	-	-	-	1.0	-
e-commerce	-	-	-	-	-	5.0	4.3	-	-	-	-	-	5.0	4.3
e-procurement	4.0	3.0	1.5	2.5	-	-	-	4.0	3.0	1.5	2.5	-	-	-
Co-design	5.0	4.0	2.0	2.2	-	-	-	5.0	4.0	2.0	2.2	-	-	-
Early Supplier Involvement	5.0	4.0	2.0	2.2	-	-	-	5.0	4.0	2.0	2.2	-	-	-
Quick Response	-	-	-	-	-	3.0	-	-	-	-	-	-	3.0	-
Vender Managed Inventory	2.0	1.0	-	1.0	5.0	2.0	-	2.0	1.0	-	1.0	5.0	2.0	-
In Plant Representative	2.0	1.0	-	1.0	-	-	-	1.0	1.0	-	1.0	-	-	-

	Table 1c							Table 1d						
SCM Capabilities	Relevant members of the ß Model’s supply chain focused in Plant C							Relevant members of the ß Model’s supply chain focused in Plant D						
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
Modularization	3.0	2.0	1.0	1.0	3.0	-	-	5.0	3.5	2.0	1.7	5.0	-	-
Just in Time	2.5	2.2	-	1.0	-	-	-	5.0	4.0	-	2.0	5.0	-	-
Just in Sequence	1.8	1.8	-	1.0	-	-	-	5.0	4.0	-	1.8	5.0	-	-
Milk Run	2.0	2.0	-	1.0	-	-	-	1.0	3.0	-	2.0	-	-	-
Supplier Park	1.0	1.0	1.0	1.0	-	-	-	5.0	2.5	1.0	1.5	-	-	-
Global Sourcing	ANP	ANP	ANP	ANP	-	-	-	2.5	2.5	2.0		-	-	-
Follow Sourcing	4.0	4.0	1.5	1.5	-	-	-	4.0	2.0	1.0	2.0	-	-	-
Postponement	-	-	-	-	-	1.0	-	-	-	-	-	-	1.0	-
e-commerce	-	-	-	-	-	3.0	2.3	-	-	-	-	-	5.0	4.7
e-procurement	1.8	1.5	1.0	1.0	-	-	-	4.0	3.0	1.0	2.5	-	-	-
Co-design	ANP	ANP	ANP	ANP	-	-	-	5.0	4.0	3.0	2.2	-	-	-
Early Supplier Involvement	ANP	ANP	ANP	ANP	-	-	-	5.0	5.0	3.0	2.2	-	-	-
Quick Response	-	-	-	-	-	1.0	-	-	-	-	-	-	4.0	-
Vender Managed Inventory	1.0	1.0	-	1.0	3.5	1.0	-	2.0	1.0	-	1.0	5.0	3.0	-
In Plant Representative	1.0	1.0	-	1.0	-	-	-	1.0	1.0	-	1.0	-	-	-

With the results presented in Table 1 it is possible to answer the Key-questions III (which SCM capabilities have been developed and Key-question V (where have they been developed) regarding the ß Model supply chains.

Based on the same four supply chain network structures presented in last heading, Table 2 displays the results of the schema application regarding the supply chain links where the SCM enablers are present. The first column contains the SCM enablers grouped by the business processes adopted by XYZ (logistics, procurement, manufacturing, marketing, and research & development). The following columns contain the relevant members of the four ß Model supply chains identified in Step V of the schema, represented in Table 2 by Table 2a, Table 2b, Table 2c, and Table 2d. The values displayed in Table 2 are interpreted as the ones in Table 1.

SCM enablers	Table 2a: Relevant members of the ß Model's supply chain focused in Plant A							Table 2b: Relevant members of the ß Model's supply chain focused in Plant B							Table 2c: Relevant members of the ß Model's supply chain focused in Plant C							Table 2d: Relevant members of the ß Model's supply chain focused in Plant D						
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
Business Process: Manufacturing / Logistics																												
Process integration	4.9	4.2	2.0	2.0	4.9	-	-	5.0	4.2	2.0	2.0	5.0	-	-	3.0	2.3	1.0	1.0	4.0	-	-	5.0	4.3	3.0	2.0	5.0	-	-
Information Technology	5.0	4.5	2.0	2.0	5.0	-	-	5.0	4.5	2.0	2.0	5.0	-	-	3.0	2.5	1.0	1.0	3.8	-	-	5.0	4.8	3.0	2.0	5.0	-	-
Level of relationship	4.9	4.4	2.0	2.0	4.9	-	-	5.0	4.4	2.0	2.0	5.0	-	-	3.0	2.5	1.0	1.0	3.8	-	-	5.0	4.6	3.0	2.0	5.0	-	-
Business Process: Procurement																												
Process integration	4.8	4.5	1.5	2.0	5.0	-	-	4.8	4.5	2.0	2.0	5.0	-	-	3.5	3.0	1.0	1.0	4.0	-	-	4.8	4.5	2.5	2.0	5.0	-	-
Information Technology	4.7	4.5	2.0	2.0	5.0	-	-	4.7	4.5	2.0	2.0	5.0	-	-	3.3	3.0	1.0	1.0	4.0	-	-	4.7	4.5	3.0	2.0	5.0	-	-
Level of relationship	4.8	4.6	1.7	2.0	5.0	-	-	4.7	4.8	2.0	2.0	5.0	-	-	3.4	3.2	1.8	1.8	4.0	-	-	4.7	4.8	2.7	2.0	5.0	-	-
Business Process: Marketing																												
Process integration	-	-	-	-	-	4.6	4.0	-	-	-	-	-	4.6	4.0	-	-	-	-	-	3.1	2.2	-	-	-	-	-	4.6	4.0
Information Technology	-	-	-	-	-	4.6	4.3	-	-	-	-	-	4.6	4.3	-	-	-	-	-	3.3	2.5	-	-	-	-	-	4.6	4.5
Level of relationship	-	-	-	-	-	4.7	3.7	-	-	-	-	-	4.7	3.7	-	-	-	-	-	3.5	2.2	-	-	-	-	-	4.7	4.3
Business Process: research & Development (R&D)																												
Process integration	5.0	4.0	2.0	2.0	-	-	-	5.0	4.0	2.0	2.0	-	-	-	*ANP*	*ANP*	*ANP*	*ANP*	-	-	-	5.0	4.6	3.0	2.0	-	-	-
Information Technology	5.0	4.0	2.0	2.0	-	-	-	5.0	4.0	2.0	2.0	-	-	-	*ANP*	*ANP*	*ANP*	*ANP*	-	-	-	5.0	4.6	3.0	2.0	-	-	-
Level of relationship	5.0	4.0	2.0	2.0	-	-	-	5.0	4.0	2.0	2.0	-	-	-	*ANP*	*ANP*	*ANP*	*ANP*	-	-	-	5.0	4.5	3.0	2.0	-	-	-

Table 2: SCM enablers present in supply chains links

With the results presented in Table 2 it is possible to answer the SCM relevant elements key-questions IV (how are the SCM capabilities enabled) and V (where have they been present) regarding the ß Model supply chains.

SCM ANALYSIS FOR THE FOUR ß MODEL'S SUPPLY CHAIN

The present heading analyzes the SCM configurations obtained with the execution of the first seven steps of the schema for SCM analysis. This analysis is the eighth and last step of the schema and addresses Key-questions VI (why does the supply chain have a given SCM configuration) and Key-question VII (when is a given SCM configuration established).

The analysis is organized according to XYZ strategic goals regarding the supply chain of the ß Model: increase the frequency of introduction of new models; increase the quality of recently launched vehicles; expand the production activities worldwide; develop and implement the COSAPP (customer-oriented sales and production process). These goals respond to the different trends that impact the automotive industry's supply chains. In order to achieve these goals, SCM capabilities have been developed in many links of the ß Model supply chains, having these links the presence of the SCM enablers.

SCM analysis under the COSAPP perspective

The XYZ strategic goal concerning the development of the customer oriented sales and production process (COSAPP) responds directly to the trend of new business orientation in the supply chain (from push to pull). The COSAPP consists of offering a large option of choices to the end customer in a way that allows the assembly of a customized vehicle using BTO practices. According to XYZ, it is impossible to develop the COSAPP without considering other supply chain members, mainly the module suppliers. Though, XYZ tries to get closer to its upstream and downstream supply chain links.

Upstream links

XYZ has been developing SCM capabilities in the upstream links of its assembly plants that turns flexible its supply chains in order to attend a customized order within a maximum timing of 10 working days and to permit order changes only six days before the vehicle is delivered to the end customer. Tables 2a, 2b and 2d indicate a strong presence of SCM enablers in the links that connect plants A, B and D with their module suppliers (member I of the supply chain) and with their high valued component suppliers (member II of the supply chain). This presence is visible either on the manufacturing / logistic process as on the procurement process. Table 2d indicates an incipient presence of the SCM enablers in the link that connects Plant D with the suppliers of the module suppliers (member III of the supply chain). This represents the search for a more advanced developmental stage for SCM of Plant D when compared to the current developmental stage for the chains of plants A and B. Base on this result it can be said that with the establishment of the Plant D's supply chain, XYZ is expanding its SCM beyond its direct chain, including now some second tier suppliers. Table 2d also indicates an incipient presence of the SCM enablers in the R&D process of this supply chain link (Plant D-Member III). The analysis of the R&D process is done later in this paper.

The continuous increase of the concentration of modules on the vehicle's final assembly line is pointed out by XYZ as an important aspect towards achieving the necessary flexibility to execute the COSAPP. The responsibility for assembling the modules is given to their suppliers, with very few exceptions, for instance the supply of engines, which responsibility belongs to XYZ. Modularization is a capability well developed in the supply chains of plants A, B and D and is supported by the presence of many SCM enablers in the supply chain links of the ß Model. This affirmation is corroborated by the following information referent to the development of this SCM capability obtained by the questionnaire:

- ✓ The module suppliers of Plant A, B and D integrate systems and modules in order to improve and optimize the manufacturing process;
- ✓ The information systems of these links are compatible and connected with each other;
- ✓ XYZ has established formal partnerships within a long period view (over many years) with its module suppliers;
- ✓ Information concerning the development of new products and its respective processes are shared with the module supplier.

In order to make more flexible the final assembly lines of XYZ plants, the modules should feed these assembly lines according to the order of the customized vehicles needs. As the modules are generally highly voluminous, highly valued and highly customized, they usually are not stocked in the manufacturer's plants. Though, the development of JIS capability is necessary. Tables 1a, 1b and 1d indicate that this SCM capability is well developed with the module suppliers (member I) in the supply chains of Plants A, B and D.

JIS is supported by many SCM enablers present in the supply chain links where it acts. This is corroborated with the following information referent to this capability obtained by the questionnaire:

- ✓ XYZ frequently exchanges information concerning production plans and capacity constrains in order to synchronize product flow, balance capacity, and manage bottlenecks through the supply chain with its module suppliers;
- ✓ XYZ establishes close cooperation concerning: following up the orders, monitoring order fulfillment performance, identifying and correcting delivery failures, and eliminating their causes through the chain with its module suppliers.

A similar analysis to the one done for SCM capabilities as modularization and JIS is also valid for JIT and e-procurement.

The modularization, JIS, JIT and e-procurement SCM capabilities have also been developed in the supply chain links that contain the highly valued components suppliers of the first tier (member II) of plants A, B and D. However, the development of these capabilities and the presence of the SCM enablers in these links are not as intense as they are for the module suppliers (member I). This is corroborated in tables 1a, 1b and 1d, regarding the development of SCM capabilities, and in tables 2a, 2b and 2d, regarding the presence of the SCM enablers.

XYZ informed that the supplier proximity to the manufacturer plants is also necessary to obtain a bigger flexibility in the manufacturing process, what is needed for the COSAPP. This proximity is associated to the development of supplier parks in the supply chains of Plant C and Plant D. In the case of Plant D, the suppliers modules follow geographically XYZ, establishing themselves in the supplier park located near this plant, what characterizes the follow sourcing capability. The inclusion of highly valued component suppliers in these parks is considered important only for the supply chain of Plant C.

Downstream links

The development of e-commerce has made possible a closer proximity with XYZ's dealers and end-customers. This is highlighted by the elevated value given to this SCM capability in the questionnaire. E-commerce has been well developed in all downstream links of the plants A, B and D, either with the dealers, as with the end-customer. E-commerce is not well developed in the supply chain of Plant C, where the developmental stage of SCM is still incipient. This incipient stage is corroborated with the shy presence of SCM enablers in the marketing process of this chain (see Table 2c). The answers obtained by the questionnaires indicate the supply chains of Plant A, B and D have information systems compatible and connected in their supply chain links, important factor to develop e-commerce. This does not happen in the supply chain of Plant C.

It was also possible to verify with the questionnaire results that e-commerce was not developed in the ß Model supply chains in order to sell vehicles stocked in dealers, practice called as virtual BTO. This fact is consistent with the COSAPP goal, because this goal does not allow stocks on downstream members. The COSAPP also justifies the inexistent of postponement of activities from XYZ to dealers.

SCM analysis under the production activities expansion worldwide perspective

The XYZ goal of expanding production activities world wide is directly related to the globalization trend acting in the automotive industry. This expansion occurs in the supply chains of the ß Model, where the production of CBU vehicles has been initiated in an emerging country plant and the assembly of CKD vehicles has been established in other emerging countries. Among the SCM capabilities that have been developed in these ß Model supply chains, the supplier parks have been playing an important rule in order to support the production expansion goal mentioned above.

The supplier park located in Europe (here called Supplier Park I) has as one of its main goals to serve as a consolidation and distribution center to provide auto parts produced in Europe to XYZ's CBU and CKD vehicles world wide plants.

Plant C has just changed from being a CKD assembly plant to a CBU production plant. This change has impacted in deep transformations in its supply chain, now in an initial developmental stage of SCM. The manufacturing / logistics and procurement processes of this supply chain have SCM enablers present, but this presence is limited basically to one supply chain link (Supplier Park I and Plant C). This weak presence of SCM enablers in the other links, associated to the weak development of SCM capabilities, makes difficult the development of SCM in the supply chain of Plant C.

According to XYZ, the 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. This improvement is reflected in the necessity to establish SCM capabilities, mainly the ones concerning logistics, for instance JIT and JIS, capabilities that are weakly developed in this chain (see Table 1c). To do so, this supplier park should host first and second tier suppliers.

Follow sourcing was also pointed out as being very relevant for XYZ in the links that connect plants A, B and D with their module suppliers (member I) and highly valued component suppliers of Tier 1 (member II).

SCM analysis under the other XYZ's strategic goals

The other two strategic goals for XYZ are the quality improvement of recently launched vehicles and the frequency increase of new models introduction. These goals are related to trends like outsourcing, reduction in the number of suppliers and reduction in the life cycle of the vehicle models. These goals are dependent from the management of XYZ upstream connections, what is highlighted in the work of Hayes *et al.* (1996). This work suggests a large proximity with the supply chain members involved in this management, mainly in the R&D process. This proximity was verified in the supply chains of Plant A, B and D by the following evidences:

- ✓ A huge participation of suppliers in vehicle projects by the development of SCM capabilities with XYZ plants like Early Supplier Involvement (ESI) and co-design;
- ✓ A strong presence of SCM enablers in the R&D process.

Both evidences are highlighted in the results synthesized in tables 1a, 1b and 1d and in tables 2a, 2b and 2d. This tables indicate that the ESI and co-design SCM capabilities and the SCM enablers are strongly developed and present in the supply chain links that connect plants A, B and D with their module suppliers (member I) and with their highly valued component suppliers (member II). This is corroborated by the following information referring the development of these capabilities that were obtained by the questionnaire.

- ✓ The supplier selection is done in the early stages of the new product development ;
- ✓ The information concerning the development of new products and its respective processes (e.g. module, technical implications, costs, time periods, etc) is shared with these suppliers.
- ✓ The information systems of these suppliers are compatible and connected with the ones of XYZ;
- ✓ When XYZ transfers activities to these suppliers it also transfers its respective activity know-how;
- ✓ XYZ has established formal partnerships within a long period view (over many years) with these suppliers.

The other links of these supply chains do not indicate the presence of SCM enablers in the R&D process, what underlines the XYZ affirmation that the vehicle manufacturer is mostly focused in the SCM implementation in its direct chain. The exception is once again the incipient presence of the SCM enablers in the supply chain links that connect Plant D with the direct suppliers of the module suppliers (member III, second tier). This represents the search for a more advanced developmental stage of SCM. This advanced stage for the supply chain of Plant D was also highlighted in the questionnaire, where ESI and co-design were considered by XYZ as being more relevant for this chain than for the supply chains of Plants A and B.

Nothing can be discussed concerning the presence of SCM enablers in the R&D process of Plant C due to the fact that the subsidiary responsible for Plant C does not play any important rule in this process. R&D is developed and managed from the mother company.

For the specific goal of increasing the quality of the recent launched vehicles, a downstream vision involving dealers and end customers is pointed by XYZ as also being important. Though, XYZ establishes a close cooperation concerning: following up the orders, monitoring order fulfillment performance, identifying and correcting delivery failures, and eliminating their causes with its dealers. The involvement of the end-customer in this cooperation is clearly indicated only in the supply chain of Plant D. The downstream vision necessary to achieve this goal is supported by the strong presence of SCM enablers in the marketing process.

Once again, the weak presence of SCM enablers is noticed in the supply chain of Plant C, as it is indicated in Table 2c.

General complementing comments

Some SCM capabilities are not well developed in the ß Model's supply chains due to the fact that they are not directly related to XYZ strategic goals regarding its supply chains. These are the cases for in plant representative (IPR), postponement, milk run and global sourcing capabilities.

Other SCM capabilities are developed in some supply chain links, although they are not directly connected to the sells of new vehicles, but related to the auto part replacement. This is the case for quick response (QR) and vender managed inventory (VMI) capabilities. Tables 1a, 1b, 1c and 1d indicate that only the supply chain of Plant D presents these capabilities well developed, what underlines again the more advanced developmental stage of SCM for this supply chain when compared with the other ß Model's chains.

CONCLUSIONS

The schema for SCM analysis consists of eight steps that consider first an industrial segment point of view and later selected supply chains that belong to this industrial segment. The schema steps are associated to key-questions that concern SCM relevant elements. This analytical schema was applied to the four supply chains of European Manufacturer (here mentioned as XYZ) vehicle model (here called the ß Model).

The goal of the present paper was restricted to the SCM analysis of the ß model supply chains, thus the paper focused its attention on the results of the schema's application based on the key-questions that regard to the ß model's supply chains point of view. The following answers to the key-questions were based on the analysis of the results obtained by the application of the schema for SCM analysis:

What *influences the SCM development?*

The answer to this key-question was based on the strategic goals of XYZ that regard the supply chain of its ß Model: to increase the frequency of introduction of new models; increase the quality of recently launched vehicles; to expand the production activities worldwide; to develop and implement the COSAPP (customer-oriented sales and production process). These goals respond to the different trends that impact the automotive industry's supply chains.

Who *are the relevant actors (supply chain members) that should be involved in the development and implementation of a SCM?*

The supply chain members were considered in an aggregated form, being grouped according to their characteristics. Seven relevant members were identified for each of the four supply chains of the ß Model. These members were almost all coincident on the four supply chains *Member I*: module suppliers (tier 1); *Member II*: highly valued component suppliers (tier 1); *Member III*: suppliers of Member I (tier 2); *Member IV*: all the supply chain members that are not considered critic towards a SCM implementation; *Member V*: in the supply chain of Plant A this member is XYZ's engine plant, in the supply chain of Plant B this member encompasses this engine plant and the Supplier Park I, in the supply chain of Plant C this member is Supplier Park I, and in the supply chain of Plant D, this member is Supplier Park III; *Member VI*: Dealers; and *Member VII*: End-customers.

Which *SCM capabilities are developed in an industrial segment,* ***how*** *are the SCM capabilities enabled and* ***where*** *are they developed and present in the supply chain network structure (supply chain links)?*

The different characteristics of each chain reflected in distinct SCM configurations. This could be seen by the development of specific SCM capabilities in some chains and not in others. The same happed with the presence or absence of the SCM enablers in the different links of each chain's business processes. The SCM configuration obtained points out that the supply chains of plant A and B have developed SCM capabilities in several of their links that belong to the direct chain of XYZ plants (module suppliers, highly valued suppliers and dealers). The main capabilities developed in these links were the following: Modularization, JIT, JIS, e-procurement, e-commerce, co-design and ESI. The SCM configuration obtained also points out that these SCM capabilities are supported by the SCM enablers considered (information technology, processes integration, and external-relationship level) in all the business processes that related to each capability. The supply chain of Plant D presents a similar SCM configuration as the ones for plant A and B when the focus is only the immediate chain of these XYZ plants. Even though there are some SCM capabilities that have been developed in Plant D chain's that are not developed in plant A and B chains' (e.g. quick response). The SCM configuration for Plant D also presents an incipient presence of SCM enablers and of SCM capabilities (e.g. co-design and ESI) in the link that connects Plant D to the suppliers of the suppliers of modules (second tier), what is not pointed out in the SCM configurations of plants A and B. The SCM enablers are still too timidly present in the business processes of the supply chain of Plant C. This timid presence precludes the development of SCM capabilities considered as being very important by XYZ (e.g. Modularization, JIT and JIS). Follow sourcing has been the most well developed SCM capability in the supply chain of Plant C, what is a consequence of the initial CBU production in Plant C.

Why *does the supply chain have a given SCM configuration and* ***when*** *is a given SCM configuration established?*

With the SCM analysis it was possible to conclude that the different characteristics and SCM configurations result in distinct developmental stages of SCM for the four ß Model supply chains.

The supply chains of plants A and B have been established for more than 20 years and most of its activities and supply chain members (both auto-part suppliers and end customers) are located in Europe. This results in a well developmental stage of SCM in the immediate chains of plants A and B which allows XYZ to achieve its strategic goals in regard to the supply chain of these plants.

The supply chain of Plant D is still not producing ß Model vehicles, what will only happen in 2005. This supply chain is being design for SCM, what means it should be state of the art and benchmark not only for the other XYZ supply chains, but also for the automotive industry. Based on the SCM analysis that considered XYZ plans for this chain, it was possible to support this last affirmation. The supply chain of Plant D demonstrates an SCM developmental stage slightly more advanced than the ones presented by the chains of plants A and B. This can be noticed in Plant D's immediate chain, where there are some SCM capabilities development that are not yet present in the plants A and B supply chains. The advanced developmental stage of SCM in Plant D is also corroborated by the expansion, although still shy, of SCM beyond the limits of the immediate chain of XYZ plants aiming the SCM development in total supply chain.

The supply chain of Plant C is still being established in order to adapt itself to Plant C new activities, now producing CBU vehicles. This chain has a good integration level within the internal supply chain of XYZ, but this integration level is very incipient beyond XYZ frontier (e.g. in its immediate supply chain). This makes possible to conclude that this supply chain presents an initial developmental stage of SCM. This initial stage makes difficult the achievement of XYZ strategic goals in regards to the supply chain of its products, here the ß Model. The development of a supplier park in the emerging country where the Plant C is located is a key point in order to establish a SCM configuration that will allow this chain to compete globally. This supplier park should support the development of SCM capabilities that will help the supply chain of Plant C to achieve a better and more advanced developmental stage of SCM.

According to the results analysis, the paper also concludes that the development of SCM capabilities occurred mainly in the immediate chain of the vehicle manufacturers. This result corroborates Rice and Hoppe (2001) and the assertion that the theory of SCM considers the whole supply chain, this theory is still far from being actually put into practice, at least when the total supply chain integration is the target. In the case of the automotive industry, the cradle of many advances in SCM, the major concern still is the links among auto-makers and first tier suppliers, links where the greatest added value to the product takes place.

ACKNOWLEDGE

We gratefully acknowledge CNPq for financial support (research projects 300432/1997-6 and 50.0031/02-9, S. Hamacher) and CAPES for a fellowship (L.F. Scavarda).

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