The Variety of Supply Chain Design: From a Standard Typology to a Relational Pragmatism

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Supply chain management is at the heart of business strategy. The types of goods delivered are extremely varied and the way to deliver to the final consumer is more and more complex. Moreover, the relations between players within the supply chain take multiple shapes and have inevitably an impact on its design. This arena of complexity leads companies to use diverse kinds of relational approaches. But the relational view is itself a large field of study and a recent trend in supply chain management. It can be focuses on joint planning, coordination, and process integration between suppliers, customers, and other partners in a supply chain. Its benefits include cost reductions, an increasing reliability and a strong responsiveness to market needs. In addition, managing a sustainable supply chain involves today additional parameters like CO_2 emissions reduction, energy consumption decrease, eradication of traffic congestion problems and the need for a better traceability. Besides, recent progresses in inter-companies' communication technologies, along with a growing use of strategic partnering, has resulted in a large variety of alternative information systems approaches for supporting a collaborative supply chain management. Helped by theories and based on empirical data from specific cases companies, this exploratory and conceptual research shows the relative influence of various specific environments on the coordination of logistics flows, with a focus on relationships between different players. This work analyzes diverse types of supply chains and gives a framework confronted with some examples showing how different players create new models of logistics organization in particular situations.

Keywords: collaboration, inter-firm coordination, organizational structure, supply chain design.

1. INTRODUCTION

For thirty years, logistics has endured profound transformations. It has now ceased to be a compartmentalized and fragmented function to become more strategic but also integrated and interconnected (Bowersox and Closs, 1996). Concentration strategies, internationalization, increasing competitive pressure, just-in-time and the overall effort to reduce costs are main reasons impacting these changes (Christopher, 2016). The multitude of stakeholders (industrials, distributors, retailers, carriers, logistics service providers) multiplies the number of potential points of connection within the same supply chain. This situation consequently complicates relationships between partners. Logistics management has gradually disappeared in the favour of the rise of supply chain management, a notion that enhances and supports a more holistic approach to the coordination of activities (Cooper et al., 1997). Supply chain management is now at the heart of business strategy (Heskett, 1977). An efficient management of logistics flows must integrate an inter-organizational view, a customer services orientation and the improvement of companies' performance (Liao et al., 2011). Supply chain management turns around three main axes that are performance (value creation provided by logistics for the firm and its partners), the market (customer service and product orientation) and the structuring organizational and technical means (Cavinato, 1992).

More recently, new challenges such as those of a more sustainable development, place the control and the coordination of international flows as one of major future challenges for companies (Hanafi et al., 2008; Sarkis et al., 2011). It is now widely recognized that cooperative relations between players of supply chains are beneficial to their

operation (Giannakis and Croom, 2004; Christopher, 2016). However, the exact nature of relationships is often dependent on the complexity and uncertainty of markets, but also management styles and business attitudes, or even social perceptions between players (Galaskiewicz, 2011). We are sometimes very far from a standard of a fully integrated and cooperative supply chain (Stevens, 1989). Many trade patterns appear and can take various forms, ranging from outsourcing contract to true strategic cooperation (Moberg and Speh, 2003). A modification of purely market relations between firms sometimes attends these changes. These adjustments require better coordination of physical flows thanks to information flows based on closer relationships between the company and its partners in a network view (Kempainen and Vepsalainen, 2003). The supply chain has gradually transformed into a wide range of different networks materialized by relationships between players themselves involved in other networks (Choi and Kim, 2008; Borgatti and Li, 2009). Such logistics networks can be characterized by the network of transport infrastructures, organizational schemes or information systems. A more strategic view completes this representation. It is gradually clarified with the development of cooperation, alliances and partnerships between players within the supply chain (Ellram and Cooper, 1990), and reinforces their agility (Christopher, 2000). The diversity of relationships and the flows of goods and information gives spatial, temporal and relational characteristics to these forms of organization. A logistics network is not a set of basic transactions but rather a corpus where relationships, time and space are embedded.

Nevertheless, a real and efficient collaboration is a recent trend in supply chain management that focuses now on joint planning, coordination and process integration between suppliers, customers, and other partners in a supply chain (Fliedner, 2003). Its benefits include cost reductions and increased return on assets, and improved reliability and responsiveness to market needs. Also, the search for a more sustainable supply chain integrates new additional parameters like CO_2 emissions reduction, limited energy consumption, a better traceability and reduced traffic congestion. Recent advances in inter-enterprise communication technologies, along with a growing use of strategic partnering, has resulted in a large variety of alternative information systems approaches for supporting a collaborative SCM. Using some distinctive case studies and a qualitative approach, this paper tries to analyze different supply chains of several economic sectors. The article presents a framework and some examples for understanding why different players create new models of supply chains and organize them. Without pretending to propose a new theoretical framework, this exploratory and conceptual work complements other research (Fisher, 1997; Rouquet and Vauché, 2015) and carries out thinking on a categorization of supply chains. The first part of the paper shows the general framework of a supply chain and presents traditional external and internal criteria impacting its design. It concludes with the presentation of elements that could lead to a categorization. In a second part, specific supply chains are presented in order to illustrate how standard solutions can be applied by some emblematic economic sectors. This section examines diverse types of supply chains and gives a framework confronted with some examples to demonstrate the complexity of logistics organization due to relationships. The paper ends with a conclusion incorporating a questioning for future research.

2. GENERIC STRUCTURE OF A SUPPLY CHAIN AND CRITERIA OF EVOLUTION

This first part of the paper reminds the generic structure of general supply chain in order to describe all elements of any logistics chain. A discussion about the impact of external/internal factors and trends that could impact logistics organization follows this description.

2.1. STRUCTURE OF A SUPPLY CHAIN

The figure 1 bellow gives an overview of the traditional structure of an extended supply chain (Curran et al., 2011,). It includes of course the two types of flows (physical flows and information flows) circulating between different players at the heart of the chain.

As show in figure 1, a supply chain is organized to make available, in a short time, products and services to customers. In this process, internal and external forces contribute to its structuration. We propose a framework integrating these forces in order to understand how supply chains are structured. To provide major elements of external and internal factors influencing a supply chain organization, this paper is inspired by the report "Future Supply Chain 2016" (GCI & Capgemini,

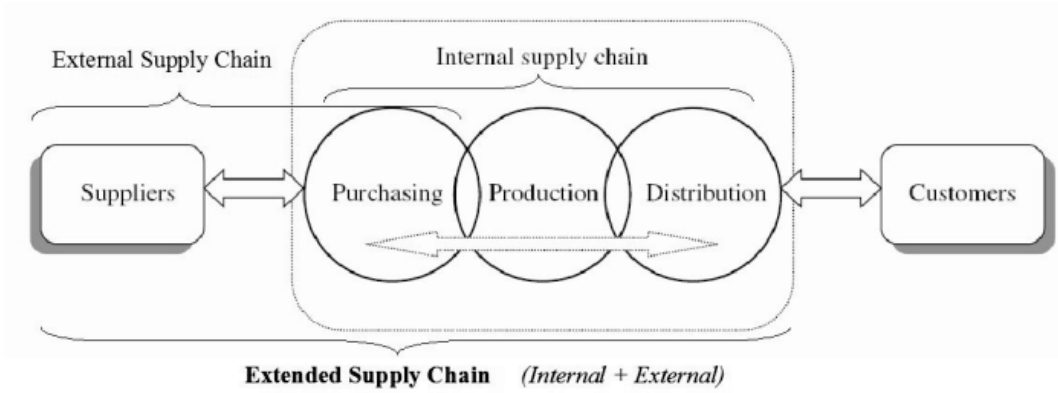

Fig. 1. Structure of an extended supply chain.
Source: Curran et al., 2011, adapted from Chen and Paulraj, 2004.

2008) and other research (Fawcett et al., 2008). First, it is considered that all supply chains involve three forms of logistics. The outbound logistics essentially provides transportation and distribution solutions. The inbound logistics ensures supplies and coordination of manufacturing operations. The support logistics is dedicated to support after sales services for durable goods, reverse logistics for packaging and products in the end of life cycle, and also hotlines to provide information about the products or services to consumers.

2.2. EXTERNAL FACTORS AND TRENDS IMPACTING THE SUPPLY CHAIN

Sometime viewed for some as competitive and strategic (Porter, 2008), a lot of external factors impact the supply chain (Kwon and Suh, 2004; Hudnurkar et al., 2014). They include competition, economic issues, natural resources availability, know-how (workforce and suppliers' ecosystem), regulatory forces, demography and technological evolutions (figure 2). These external forces are difficult to influence but can provide consequences on the supply chain organization and its management. If all stakeholders worked in a coordinated manner, the supply chain as a whole would better respond to customers through product and information flows more consistent with the consumer behaviour and external forces.

The supply chain uses and consumes a plurality of resources. Its design must integrate resources location and their quantities. Also, the supply chain needs to convince consumers that it's operating in a green and responsible manner (Sarkis, 2011).

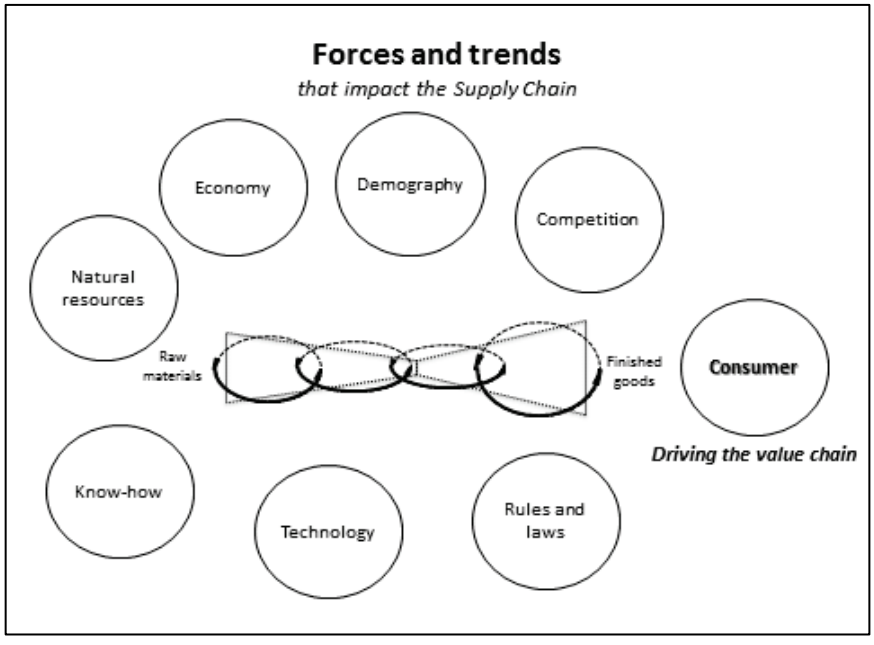

Fig. 2. External forces and trends impacting the supply chain.
Source: own representation.

The preservation of resources like water, energy and raw materials must be integrated in supply chain new projects. Compared with North America and Western Europe, East Europe, Brazil, Russia, India, China and Africa will be major markets to consider in the coming years. Each of these markets will be probably impacted by significant and quick changes. There will also be changes in the balance between local and global sourcing. The future will be dramatically changed by shifting demographics, such as the population ageing in Western countries and the increase in urban residents. For example, it is projected that 70% of the world's population will be urban by 2050 (Schafer and Victor, 2000).

Competition is a major factor impacting the supply chain (Rezapour et al., 2014). With the globalization, a large number of supply chains are under pressure from worldwide competitors. This struggle between supply chains has its positive side. It forces companies and supply chain managers to innovate with an idea of perpetual quest for customer satisfaction (Morvai and Varga, 2011). In addition, to consumer pressure and companies own growing emphasis on corporate social responsibility, governments will enact more regulations, particularly targeting areas such as sustainability. This will be done by government and regulatory bodies at different levels: local, national and international. Moreover, some current labour regulations could be repealed (for instance, to improve flexible working times) to allow infrastructures to be used to their full capacity with less stress on the environment.

The technology used in each link impacts the supply chain. Material and information flows are concerned by the technology. We have assisted these last years a truly revolution of information technologies and it seems that this phenomenon will follow in the future. The know-how of suppliers and workers influence the supply chain and collaboration (Simatupang et al., 2002). It not unusual to meet an ecosystem of a particular know-how within a supply chain. For example, in the case of electronic products, it is difficult today to obtain compounds and labour in manufacturing and assembling products without going through Asia. For certain agricultural products (fresh fruits, cereals), some countries or regions are essential. As well as the ecosystem of consumers, the ecosystem of know-how should be taken into account when a company designs its supply chain.

2.3. INTERNAL PROPERTIES INFLUENCING THE SUPPLY CHAIN

If the supply chain undergoes and adapts to external factors, it is also forged thanks to the products and services that it carries (Fisher, 1997; Beamon, 1998; Carter and Ellram, 1998). Major characteristics associated with product flows that influence the supply chain are:

- The number of links required to obtain products;
- The range of different products made by cycle;
- The volume of products made by cycle;
- The cycle time of each loop;
- The life cycle of each product.

The number of links and therefore the number of decision makers may be more or less important in a supply chain. This aspect influences the responsiveness of the chain and also impacts the ability of cohesion of the different players (Cao et al., 2010). In the supply chain of the automotive industry, the number of links in such a chain is traditionally considered with five elements: the customer, the dealer, the manufacturer, the suppliers and the supplier of supplier. In the agro-food sector, manufacturers of dairy products like yogurt, must produce and offer a broad range of references to its customers. It should be noted that historically, these supply chains produced a large volume of products, but the number of references was quite limited. In the last three decades, these chains have been duty to produce a range of products that has expanded hugely in order to capture and retain market shares. Supply chains support the production of a more or less important products quantity. For instance, a beverage plant can produce a various number of bottles of water per day.

As for the number of links, the lead-time of a link influences the responsiveness (Treville et al., 2004). However, it has less impact on the cohesion of the chain since it is the responsibility of a single decision maker. The life cycle of the product impacts the supply chain because it imposes a more or less consistent reverse logistics. The life cycle of product influences the volume of production and the inbound and outbound logistics too.

2.4. ELEMENTS HELPING A CATEGORIZATION

To establish a typology of products, it is necessary to define levels for each characteristic. In fact, as for all typologies, this step is essential to simplify the reality and create categories. For example, the length of the chain is hardly comprehensible. Moreover, it may still have a certain amount of subjectivity in how to identify the links forming a chain. In the automotive supply chain, many actors are presents: customers, dealers, manufacturers (brands), direct suppliers, suppliers of suppliers. Some suppliers' suppliers may also have their own suppliers to formalize a relatively extended chain and a complex network. To define how many links this supply chain has, the role of the manager[1] of the supply chain must be seriously take into consideration and all links have a direct impact for him.

The variety of products evolves in every link of the supply chain. To propose a typology that limits the number of types, the following convention is chosen:

- Very low: do not exceed ten references;
- Low: do not exceed thirty references;
- Medium: about a fifty references;
- High: about a hundred references;
- Very high: more than a hundred references.

The following levels for the number of products made per cycle are considered:

- One product;
- Very small series: a dozen of products;
- Small series;
- Mass production: hundreds of products;
- Continuous.

The cycle time of a chain connection can be quite different from a supply chain to another. For each duration, we propose that following characteristics:

- Very short: one day or less;
- Short: some days;
- Long: some weeks;
- Very long: some months.

The product lifecycle can be more or less important. Three categories of products in function of their lifecycle are proposed:

- Consumables: the range of the lifecycle of this kind of product is from several days to several months;
- Durable: the lifecycle of these products is measured in years;
- Very durables products: the lifecycle for these products are measured in decades.

3. FROM A REGULAR VISION TO A DIVERSITY OF SUPPLY CHAINS

In this second part, particular supply chains are chosen in order to illustrate how solutions can be applied. A distinction is made among regular replenishment, promotional and seasonal flows. The aim of this part is to show the diversity of supply chain organization that can be met in the economic world. It provides a framework confronted with some examples to demonstrate the complexity of logistics organization in particular due to the influence of relationships. The results of this proposition should provide inspiration to companies in order to adapt these archetypes to their own situation.

3.1. DIVERSITY OF SUPPLY CHAINS: ATTEMPT OF CONCEPTUAL CLASSIFICATION

Before to describe each case presented, this sub-section of the paper proposes and comments a classification in six archetypes of supply chain. The first is linked to the case of vegetables. The supply chain for fresh vegetables is characterized by local and global sourcing and short cycle time (the product should reach the market as quickly as possible). It is important to mention the critical importance of product quality and freshness, the seasonality of some vegetables, and the flow often characterized by a long distance from sources to consumers (Grimsdell, 1996). The cereals supply chain represents a second type. It is characterized by seasonal raw material production, regular consumption patterns (but possibly influenced by special discounts) and remote as well as local sourcing of course depending on the country of harvest. Overall, there is improvement potential on stock levels and the length of stay of stocks at distribution centres and on retailers' shelves. In the majority of cases, transportation and storage facilities could be improved in respect to energy consumption (Hamprecht et al., 2005). The physiognomies of the beverages industry inspire a third type. The beverages retail supply chain is characterized by relatively high inventory costs

[1] In the paper, each supply chain is considered with a leading manager even if sometimes it is possible to find supply chains sharing the leadership between two managers.

and opportunities to reduce transport and fuel expenses (Pagell and Wu, 2009). Also, there is a potential improvement regarding the collaboration on both forecasting and logistics (either upstream from the raw material suppliers and manufacturers or downstream from manufacturers and retailers or among manufacturer competitors). This is also the same situation for data exchange which still involves a lot of physical operations. The dairy products supply chain is close to the beverages supply chain in terms of product cycle time and distribution channel. However, distinctive elements make this chain singular and encourage investigations. This supply chain generates a broad range of products and the best-use date is quite low. An additional constraint is the respect of the temperature and each step of that supply chain that must work lean from supply to distribution. It is essential to design the supply chain for supporting traceability of goods (Manikas and Manos, 2009). A type of consumer durables is at the origin of the fifth category. There is an accelerated internationalization by emerging multinationals markets for the white goods sector (Bonaglia et al., 2007). The main characteristics of the white goods supply chain include long lead-time from source to consumer. The mastery of inventory levels is essential, especially at retailer's level (many retailers hold inventory even though it needs to be delivered). Stocks locations must be reduced. Physical distribution and reverse logistics are two major operations. Collaboration and integration with other parties must be continually improved. Home delivery must be more flexible and opportunities exist involving standardization of products. Finally, the well-known case of the automotive industry constitutes the sixth category. The automotive supply chain is traditionally characterized by its flexibility and its performance (Martínez-Sánchez and Pérez, 2005). Like white goods, this chain has a long lead time from source to the dealer and customer. Just-in-Time philosophy was born in this sector and the stock levels must be well controlled despite of the wide range of models sold. This supply chain knew in the past a relation of power between the manufacturer and his suppliers. Today, this relation seems to be more equilibrated, probably because the size of suppliers and their influence on innovation has increased over the last twenty years.

An overview of main characteristics (variety, products per cycle, cycle time and life cycle) of these six conceptual classes of supply chains are identified in table 1. These six types could be useful as a first stage to apprehend the functioning of the majority of existing supply chains.

Table 1. A conceptual vision of six particular supply chains.

Product	Variety of products	Products per cycle	Cycle time	Life cycle
Vegetables	Very low	Mass series	Very long	Consumables
Cereals	Very low	Mass series	Very long	Consumables
Beverages	Low	Continuous	Short	Consumables
Dairies	Medium	Continuous	Short	Consumables
White goods	Medium	Small series	Long	Durable
Automobiles	Very high	Mass series	Long	Durable

3.2. PRAGMATIC SOLUTIONS APPLIED BY SOME MULTINATIONAL COMPANIES

Nowadays, thanks to new technologies of information and communication, it is really easy to connect any player of a supply chain. In theory, from the supplier of the supplier to the final customer, all actors can be directly connected to each other in a fully integrated supply chain. But the reality is sometimes quite different from the theory. Even if the communication tools become more and more efficient and connectable, players do not always communicate with each other. The standardization of communication tools does not necessarily lead to a standardization of relationships within the same sector and the same supply chain. On another side, economic pragmatism also forces companies to cooperate and reconfigure their supply chain management. As a result, this diversity of situations leads sometime companies to customize their supply chain organizations. Through some empirical examples, this sub-part has two objectives. First, show differences that may exist between conceptual supply chains of economics sectors describe in the previous sub-section and the empirical reality. Second, confirm the huge complexity and the modularity of supply chains due to relationships.

For each type presented, a qualitative method using a case company was adopted (Eisenhardt, 1989; Miles et al., 2014). A single case is often the material of a qualitative research, especially if it is chosen to be revelatory (Yin, 2013). Yin (2013) also suggests a case is appropriate when the subject of interest is in its infancy and when "how" or "why" questions are being asked. Testimony analyses and data collection coming from diverse sources (press articles, etc.) formed the foundation

of the methodology. This orientation allows a holistic view for the description of all supply chains studied.

3.2.1. Relationships between Nestlé and Carrefour

The first example is based on the relation between two famous multinational companies, Nestlé and Carrefour. Super and hypermarkets are connected with the central purchasing and with Nestlé. Thanks to the collaboration between these three players, the consumer is better satisfied and the stock level is well managed. This causes a reduction in destruction of expired products. The figure 3 presented bellow show a physical integrated and bordered supply chain. Although the other players (suppliers, etc.) are connected and play a key role (for instance, as part of procurement operations), central and specific relationships within this triad characterize and enhance this supply chain. In this triad, the collaboration is strongly reinforced.

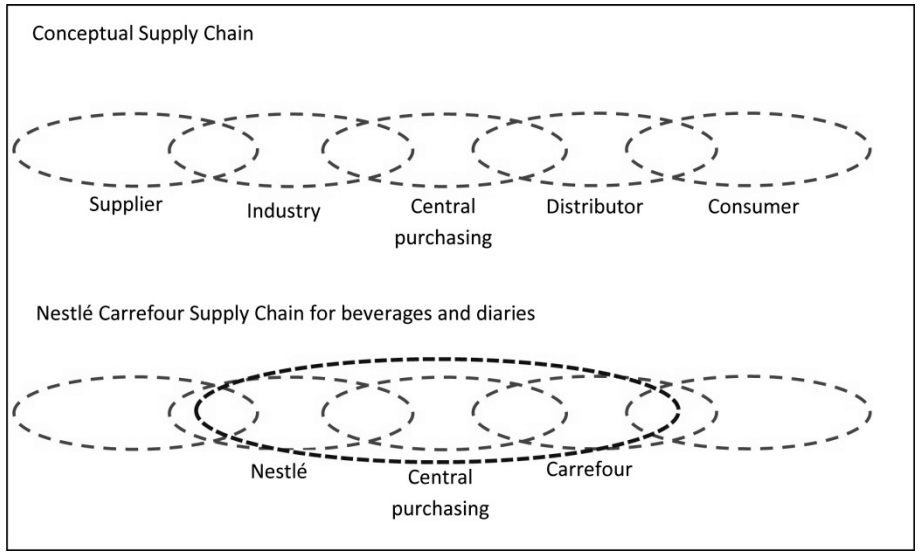

Fig. 3. Nestlé and Carrefour: an integrated and delimited supply chain.
Source: own representation.

3.2.2. Sony and Universal: coopetition within the same supply chain

For the distribution of the physical music (CD, DVD), two major competitors, Sony and Universal, cooperate and share information about demand and stocks. With the help of a Logistics Services Provider (LSP) and a system of pooling connected to a Collaborative Planning and Forecasting for Replenishment (CPFR) tool, they work together and, as a result of their collaboration, the supply chain offers a high level of service and keeps the stocks in a relatively low level. This "coopetitive" supply chain is particularly useful to save a lot of money for a declining sector like the physical music industry. Sony and Universal decided to work sharing and mutualizing distribution centre and downstream transports (a pooling system). In this case of coopetition (Brandenburger and Nalebuff, 1997), the two companies have cut costs considerably. Also, costs of infrastructure and transports have been seriously reduced (especially for the last mile logistics operations). By cooperating in the same supply chain, competitors have found a supplementary advantage: sharing resources to increase the delivery frequency. Finally, it is a quite similar configuration that already used in the cereals supply chain where different producers share warehouses and distribution facilities. The figure 4 describes this specific situation.

3.2.3. The case of Toyota and PSA: the joint venture approach

The automotive industry is traditionally competitive and cooperative. A lot of examples of collaboration between competitors exist. The case of the joint-venture between Toyota and PSA seems particularly interesting to study in a logistical and relational point of view. Both of them had an interesting project to create a new city car named 108 and C1 for PSA, and Aygo for Toyota. When they understood that the volume of demand was probably not enough to build a new plant, they decided to create a unique factory for both brands. Toyota Peugeot Citroën Automobile (TPCA) is a joint-venture of Toyota Motor

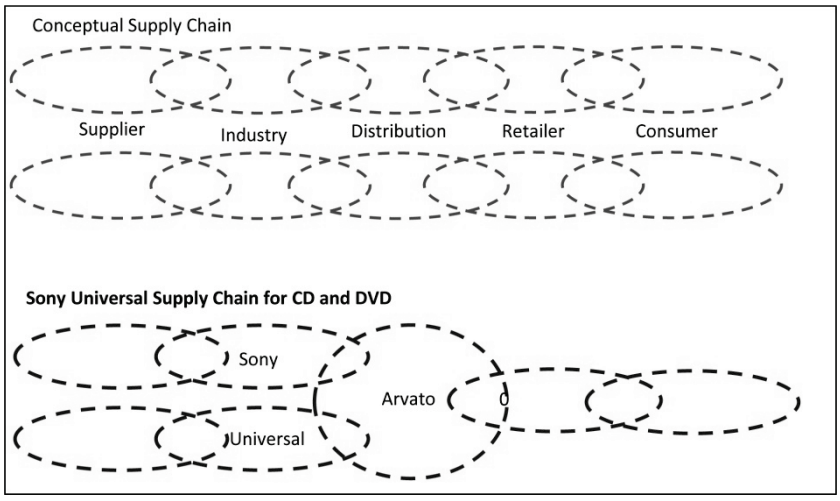

Fig. 4. The case of Sony and Universal: a coopetition to reduce logistics costs.
Source: own representation.

Corporation and PSA Peugeot Citroën built in 2002 in an industrial zone in Slovakia. Since 2006, the Trnava plant has been a success story. The firm employs about 4,000 people and produces 300,000 vehicles per year.

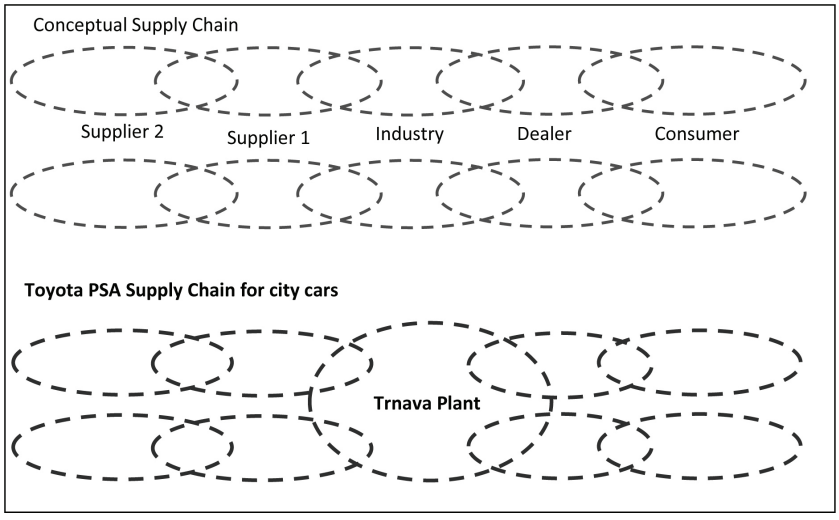

Fig. 5. The TPCA joint-venture: an integration to optimize capital.
Source: own representation.

For a supply chain requiring significant capital and using a fairly well-known and matured technology, this kind of partnership has been considered as an attractive logistics option. Alliances, projects shared and co-engineering are quite common in the automotive supply chain. This organization brings good results and looks like the supply chain of the white goods sector. The figure 5 gives a logistics vision of the partnership. With this example, we note that the joint venture becomes the nodal link between two supply chains of competitors that normally should be completely independent. This leads to a greater need for cooperation between competitors in order to organize efficiently the management of physical and information flows. Moreover, this situation calls for greater integration of information systems.

4. CONCLUSION AND FURTHER RESEARCH

This conceptual paper presents in a first part, the general framework of a supply chain influenced by traditional external and internal criteria impacting its design. After a proposal of categorization and with the help of different explorative case studies coming from emblematic economic sectors, the article demonstrate the complexity of logistics organization due to relationships between players within the supply chain. It seems that the nature of the relations between actors (competition, collaboration, etc.)

can have an influence on the organization of logistical flows and challenges the conventional patterns of supply chain organization. Due to the pragmatism, the reactivity or proactivity of players, there are emerging supply chains that can take different shapes in the same sector of activity and upsets existing patterns. The nature of relationships between the different links becomes the new paradigm that will undoubtedly be at the origin of a reconfiguration of many supply chains at a local, national and global level. It should also lead companies to rethink their flows management as a "relational supply chain management" (RSCM). Thus, it might be relevant to develop new research on a comparison of the principles of cooperation within diversified supply chains in different economic sectors. It would be particularly interesting to make a comparative analysis of these "relational supply chains" in terms of logistic and economic performances.

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